State Indicators of Science and Mathematics Education

1990

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Council of Chief State School Officers
State Education Assessment Center

STATE INDICATORS OF SCIENCE AND MATHEMATICS EDUCATION
1990

Rolf K. Blank
Melanie Dalkilic

The State Science and Mathematics Indicators Project is supported by a grant from the National Science Foundation. The state indicators were developed through the cooperation of the state departments of education and the National Center for Education Statistics.

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OVERVIEW OF STATE INDICATORS OF SCIENCE AND MATHEMATICS EDUCATION

The Council of Chief State School Officers (CCSSO) is leading the development of a state-by-state system of indicators of the condition of science and mathematics education. The state indicators will aid state, national, and local education decision-makers in assessing the rate at which progress is made in improving the quality of science and mathematics education in our schools. Many of the state education policy reforms in the 1980s were aimed at improving the quality of science and mathematics education in elementary and secondary schools. States have raised standards for teacher certification, increased course requirements for graduation, revised state curriculum frameworks, and established new and innovative statewide student assessments. The national educational goals set out by the President and governors in 1990 provided a target for improving science and mathematics learning of all students, becoming first in the world by the year 2000. The goals statement emphasizes the importance of a sound capacity for assessing performance towards the achievement goals (National Governors Association, 1990). Both state and national efforts to improve science and mathematics education require a system of reliable, periodic indicators for tracking progress.

The CCSSO Project on Science and Mathematics Indicators, supported through a grant from the National Science Foundation (NSF), has two objectives: (1) to improve the quality and usefulness of data on science and mathematics education, so state policymakers and program managers can make more informed decisions; and (2) to define and implement a set of indicators, national and state level analyses of progress in improving science and mathematics education.

SUMMARY OF STATE SCIENCE AND MATHEMATICS INDICATORS FOR 1990

This report provides the first ever state-by-state data on key indicators of the condition of science and mathematics education in schools. The indicators are based on two data sources. First, state departments of education collected data on students and teachers in *public schools,* and reported the data to CCSSO using common definitions and categories. Data on course enrollments were reported by 38 states and 47 states reported data on teacher characteristics. National estimates were computed using statistical imputation for missing states. Second, data from the National Center for Education Statistics' Schools and Staffing Survey were analyzed to obtain additional indicators of science and mathematics teachers. The Survey includes a national- and state-representative sample of public school teachers at elementary and secondary levels.

Instruction and Participation in Science and Mathematics

Course Taking in Mathematics. As of the 1989–90 school year, we estimate that nine percent of public high school students in the U.S. take calculus by the time they graduate, 49 percent take algebra 2, and 81 percent take algebra 1. Two percent of students take advanced placement calculus. These statistics are based on state course taking data reported by common categories and definitions. Course taking varies by state at all levels, e.g., the proportion of students taking algebra 2 varies among states from 65 percent to 33 percent. High school mathematics courses taught with an integrated curriculum approach are incorporated in the state indicators.

Course Taking in Science. Using 1989–90 state course taking data in science, we estimate that 20 percent of public high school students in the U.S. take physics by the time they graduate, 45 percent take chemistry, and 95 percent take biology. The proportion of students taking chemistry varies by state from 62 percent to 33 percent. Enrollments in advanced placement courses are two percent in biology, one percent in chemistry, and less than one percent in physics.

Elementary Instruction. Elementary teachers report that they spend 4.9 hours per week on mathematics and 3 hours per week on science in grades 4–6 in the median state. The state figures for mathematics vary from 4.1 hours to 5.5 hours per week, and the time spent on science varies from 2.2 to 4.1 hours per week.

State Policies and Course Taking in Science and Mathematics. The state indicators on high school course taking as of 1989–90 confirm other research showing increased enrollments in science and mathematics during the 1980's when state graduation requirements were raised in many states. State course taking rates show somewhat higher enrollments at all levels but the largest increases were at the level of algebra 1 (to 81% of students) and first year biology (to 95% of students).

State Policies and Mathematics. Eleven states requiring from two and a half to three credits of mathematics for graduation have a median of 10 percent more students taking mathematics courses than states requiring two credits or less. However, the high requirement states have a median of only two percent more students taking upper level mathematics courses, e.g., geometry through calculus. These results indicate that, on average, higher state graduation requirements do not necessarily lead to substantially more students taking upper level mathematics courses. There are individual state exceptions to this pattern.

State Policies and Science. Five states requiring two and a half to three science credits have a median of nine percent more students enrolled in science than states requiring two or fewer credits. The high requirement states have a median of four percent more students taking upper level science courses, e.g., chemistry, physics, and advanced biology. There is some evidence that a science graduation requirement above two credits is related to more upper level science course taking, but the data are not conclusive because of the small number of states with higher science requirements.

Gender Differences. Girls and boys in all 16 states that reported data by gender have almost equivalent rates of enrollment in science and mathematics courses up to advanced course levels. In most states, boys have higher enrollments in physics and advanced mathematics courses, e.g., trigonometry and calculus, and girls have higher enrollments in advanced biology courses.

Need for Data on Implemented Curriculum. To analyze the quality of the curriculum that is provided to students, information is needed on content of the implemented curriculum, and particularly how the content in a course or grade level varies within and among states. CCSSO will be working to develop an appropriate methodology for collecting such information on a state-by-state basis.

Teacher Quality and Teacher Supply and Demand

Total Current Teachers. In grades 9–12, there are a total of approximately 111,000 teachers of mathematics and 102,000 teachers of science in the 50 states and D.C.

Teacher Preparation—Teaching Out-of-Field. Among teachers in 30 states, nine percent of high school mathematics teachers are not certified in math, and eight percent of biology teachers, eight percent of chemistry teachers, and 12 percent of physics teachers are not certified in these fields. State-by-state data show that some states have 20 to 30 percent of mathematics and science teachers assigned out-of-field while others have none out-of-field.

College Majors. Forty-two percent of all high school teachers of mathematics have a mathematics major, and 54 percent of all teachers of science majored in a science field. The percent of teachers with majors in mathematics varies by state from 20 to 62 percent, and in science from 31 to 73 percent.

Equity in the Teaching Force—Gender. The majority of high school science and mathematics teachers are male, but the gender distribution varies by field. Forty-five percent of mathematics teachers are female, while 22 percent of physics teachers are female. The percent of female teachers in mathematics varies by state from 21 to 69 percent, and the percent of female teachers in physics varies by state from 10 to 49 percent.

Race/Ethnicity. State data on the race/ethnicity of science and mathematics teachers show that there is a wide disparity between the supply of minority science and mathematics teachers and the proportion of minority students in virtually all states.

Current Teacher Supply—Primary Assignments. State indicators of science and mathematics teachers are reported by primary vs. secondary assignments. In the median state, 82 percent of high school teachers of mathematics have their primary assignment in mathematics, 63 percent of teachers of biology have their primary assignment in biology, and 24 percent of teachers of physics have their primary assignment in physics.

Teacher Age. Based on state data, 19 percent of high school mathematics teachers and 22 percent of science teachers are over age 50. By comparison, 21 percent of all high school teachers are over age 50. The proportion of mathematics teachers over age 50 varies by state from 10 percent to over 30 percent.

School Conditions—Class Size. The average class size in high school mathematics is 21 students per class and the average class size in science is 22 students per class. These figures compare with an average class size in high school English of 22 students per class. States vary in average mathematics class size from 14 to 29 students and in science class size from 15 to 28 students.

Number of Teachers and Schools per State. State data show that 11 states have more high schools than assigned chemistry teachers, and 28 states have more high schools than assigned physics teachers.

Better State Data on Teacher Quality. The state science and mathematics indicators provide basic information on the characteristics and qualifications of teachers. Many states expressed a need for information on the quality of teacher knowledge and skills in their subject and their teaching practices. CCSSO will be working to develop a method of obtaining these kinds of data.

DESIGN FOR STATE SCIENCE AND MATHEMATICS INDICATORS

The State Science and Mathematics Indicators Project is part of the efforts of the CCSSO State Education Assessment Center to establish a system of state-by-state educational indicators that are used to regularly report on the condition of education in the nation and states. The Assessment Center was established in 1985 to coordinate the development, analysis, and use of state level data. The Council charged the Assessment Center with implementing an education indicators model for reporting state-by-state data. The CCSSO indicators model (1985) has three components: (a) state educational outcomes, (b) state education policies and practices, and (c) state context. The objective is to analyze student outcomes by indicators of state policies and education practices, and account for differences in state demographic and fiscal characteristics.

Indicator Models for Science and Mathematics

The CCSSO Project on science and mathematics indicators is consistent with other efforts of the National Science Foundation to assess science and mathematics education in the nation. In the 1980s, NSF committed significant resources toward developing a set of indicators that would provide a reliable basis for systematic, regular monitoring of the condition of precollege science and mathematics education. NSF's Office of Studies and Program Assessment in the Science and Engineering Education (now, Education and Human Resources) Directorate has supported several projects aimed at developing a system of indicators of the condition of science and mathematics education in the nation's schools, including a national survey of science and mathematics teachers (Weiss, 1987), analyses of the quality of current science and mathematics education indicators and recommendations for improvement (Raizen and Jones, 1985; Murnane and Raizen, 1988), planning for a national indicators system (Shavelson, et al., 1987), and analyses of the International Association for Education Evaluation (IEA) assessment of mathematics (McKnight, et al., 1987).

The results of NSF's activities with science and mathematics education indicators are documented in its biennial report to Congress, *Science and Engineering Indicators*, in the chapter on "Precollege Science and Mathematics Education" (National Science Board, 1989). The chapter reports on the status of science and mathematics education using an indicators model that includes: *inputs* (e.g., teacher quantity and quality, curriculum content), *processes* (instructional time, course enrollment), and *outcomes* (student achievement). CCSSO's Science and Mathematics Indicators Project will biennially report state indicators using a similar model of educational indicators.

The state science and mathematics indicators are also part of the annual CCSSO report, *State Education Indicators*. This report was established with the state superintendents decision in 1985 to develop and publish state-by-state comparative data to provide a valid basis for tracking educational progress in the U.S. (CCSSO, 1989a).

CCSSO has worked with state departments of education, national education officials, scientists, mathematicians, educators, and researchers to select and develop a set of priority indicators for science and mathematics. Three major steps were included: (a) identifying desired indicators based on research and policy needs; (b) obtaining input from states on state data and indicator needs; and (c) planning with states for a state data reporting system.

Selection of State Indicators

In the first year of the Project, a conceptual framework paper was developed which reviewed existing knowledge about, and needs for, better indicators of science and mathematics education and outlined a rationale for selecting indicators based on a model of the education system (Blank, 1986). The paper was based on recent studies concerning the condition of science and mathematics education and educational indicators (National Science Board, 1983; Raizen and Jones, 1985; Shavelson, et al., 1987; Murnane and Raizen, 1988; Oakes, 1986; Weiss, 1987). A Project Advisory Board (comprised of scientists, mathematicians, researchers, educators, and state and national education officials) used the conceptual framework as a starting point in identifying a list of ideal indicators that would be desirable for measuring progress in science and mathematics education at state and national levels. Six categories of indicators were specified: student outcomes, instructional time/participation, curriculum content, school conditions, teacher quality, and equity.

Analysis of Priority Indicators. The ideal indicators were analyzed against current data availability using results of a survey of state departments of education and a review of national surveys. A task force comprised of state education specialists and Project advisors used the analysis in recommending a set of indicators that should be given high priority for development on a state-by-state basis. The priority indicators could be based on existing data sources or require new data collection. Three criteria were used in selecting the priority indicators: (a) the importance and utility of an indicator at national and state levels, (b) technical quality of data that can be obtained, and (c) the feasibility of obtaining the required data. The priority indicators are listed in Figure 1 with the recommended source of state-by-state data.

Input from States. A survey of state departments of education was conducted in the first year of the Project to determine the availability of state data on the ideal indicators and to identify state interest in indicators (Blank and Espenshade, 1988a). Teams of state specialists in assessment, science and mathematics curriculum, and information systems were asked to respond to the survey. The survey also covered state policies related to science and mathematics education, including curriculum, teacher certification, testing, and graduation requirements (Blank and Espenshade, 1988b).

The ideas and interests of state departments of education concerning science and mathematics indicators were also obtained through a series of five regional conferences. The conference sessions included presentations by national experts on education indicators, discussions among states on the development and use of indicators, and meeting of Project staff and state representatives to analyze the capacity of each state to collect and report data.

Plan for Reporting Data. A data reporting plan was designed for the priority indicators to be obtained from state-collected data. The Project staff met with a task force of state data managers and science and mathematics specialists to develop a data reporting plan for three indicators: secondary course enrollments in science and mathematics, characteristics of science and mathematics teachers, and teacher certification status. The plan included a taxonomy of course categories, definitions of the categories, teacher assignment and certification categories, and formats for reporting state-aggregate statistics.

A consensus process was used to develop a data reporting plan that would produce comparable state data. State representatives worked together to define common reporting categories that are sufficiently specific to provide meaningful analyses of enrollment trends and teacher characteristics, but also broad enough to accommodate differences in state data definitions and categories. The consensus process was significantly aided by including state specialists in science and mathematics (data users) as well as state data managers (data providers) and by having representatives from large and small states. A pilot study of the plan was conducted with data reported by 10 states for the 1987–88 school year. With the results of the pilot test, a state task force revised the plan, and data reporting instructions and forms were prepared.

In the 1988–89 school year, 39 states participated in a trial run of the data reporting plan. Data were collected by state departments of education using regular state-designed information systems, the data were reported to CCSSO, and a preliminary report on the indicators was produced (Blank, 1990). The report illustrated uses of the state-by-state indicators, and it was used to obtain feedback from NSF, states, and Project advisors on how data and analyses should be reported.

METHODOLOGY FOR COLLECTING DATA

CCSSO requested that all states collect data on indicators of student course enrollments in science and math, teacher characteristics, and teacher certification as of October 1, 1989 (CCSSO, 1989b). Then, states were asked to report state aggregate numbers on the indicators to CCSSO using a common reporting form. The data were reported on students and teachers in *public* schools only. In 1989–90, a total of 47 states reported data on one or more of the requested indicators. In succeeding biennial cycles of data reporting, CCSSO will be working to have complete 50 state participation.

States used their own data collection instruments. About half the states collected universe data on course enrollments and teacher characteristics with a questionnaire completed by all teachers. Other states collected universe data on course enrollments with a school level form and collected universe data on teacher characteristics with a teacher questionnaire. One state used a sampling method for collecting data on course enrollments. All states reporting on teacher certification status used computerized state certification files. CCSSO surveyed states on their data quality and data editing procedures. The average state had complete data from over

Figure 1
Priority State Indicators of Science and Mathematics Education (Approved by CCSSO, November 1987)

PRIORITY SCIENCE/ MATHEMATICS INDICATOR	DATA SOURCE
Student Outcomes	
Student Achievement	NAEP (not yet reported)
Student Attitudes/Intentions	NAEP (not yet reported)
Instructional Time/Participation	
Grades 7–12 Course Enrollment	State Data (CCSSO)
Elementary Minutes per Week	Schools/Staffing Survey (SASS) (NCES)
Curriculum Content	
Students' "Opportunity to Learn"	Data not available
School Conditions	
Class Size by Subject/Course	SASS (NCES) or State Data
No. of Course Preparations per Teacher	
Course Offerings per School	
Teacher Quality	
Courses/Credits in Subject	SASS (NCES)
Teaching Assignments by Subject, by Age, Gender, Race, Ethnicity	State Data (CCSSO)
Teaching Assignments by Certification Field	State Data (CCSSO)
Equity	
Gender and Race/Ethnicity of Students and Teachers	State Data (CCSSO)

99 percent of respondents (schools or teachers). Further information on state data collection and reporting are available from CCSSO.

For this report, CCSSO also analyzed data from national level surveys conducted by the National Center for Education Statistics (NCES). The Schools and Staffing Survey (SASS), conducted in 1988, provided data on teacher preparation in science and math, teachers' work load, and elementary class time. State data reported to NCES through the Common Core of Data for 1989–90 provided state totals on student membership, teachers, and schools. Data from the NCES National Transcript Study (Westat, 1988) were used to compute cohort statistics based on state course taking patterns.

OTHER PROJECT ACTIVITIES WITH STATE INDICATORS

CCSSO has undertaken several other activities to improve indicators of science and mathematics education. With support from NSF, CCSSO organized a conference on "Alternative Methods of Student Assessment" in January 1989. The conference, attended by representatives from 35 states, presented results of recent studies and experimentation with hands-on exercises and performance assessment in science. Presentations were made by representatives of the Second International Science Study, Educational Testing Service, National Center for Improving Science Education, and the state departments of education in Connecticut, New York, Michigan, and California (Blank and Selden, 1989).

CCSSO convened a two-day meeting of state science supervisors and researchers to begin planning for indicators of elementary science. A draft school level survey that would provide several indicators for states was developed, and it was circulated to states for their consideration and use. No decision has been made on implementation of the survey on a state-by-state basis.

Finally, CCSSO has produced several reports from the results of the 1987 survey of states, including a report on state policies on science and mathematics education and a 50 state analysis of available state data. Three reports have been produced on the design and use of state indicators. All the products from the CCSSO Project are listed in the References section.

RESULTS OF STATE SCIENCE AND MATHEMATICS INDICATORS: 1990

The initial results on state-by-state indicators of science and mathematics education are reported according to the six categories of indicators selected by the Project Advisory Board: student outcomes, instructional time/participation, curriculum content, school conditions, teacher quality, and equity. Indicators of educational equity are included in the description and analysis of indicators in the five other categories.

INDICATORS OF STUDENT OUTCOMES

Two indicators were selected under the first category, Student Outcomes. State-by-state data on student achievement in science and mathematics and student attitudes concerning science and mathematics education will be available through the National Assessment of Educational Progress (NAEP). The CCSSO Project will report these indicators as they become available. In 1991 the first state level results on mathematics at the 8th grade level will be released. In succeeding biennial assessments of NAEP, additional levels of mathematics and science will be tested and results will be reported. The 1992 NAEP will expand state-by-state mathematics assessment to 4th and 8th grade. CCSSO is currently leading a consortium of education organizations, scientists, and educators in developing the assessment objectives for the 1994 NAEP in science.

INDICATORS OF CURRICULUM AND INSTRUCTIONAL TIME/PARTICIPATION

CCSSO has developed state indicators that can be used to track the progress of states and the nation in providing and improving science and mathematics education.

National Commissions and State Policy Reforms. The national commission reports of the 1980s recommended increases in science and mathematics instruction for all students (National Commission on Excellence in Education, 1983; National Science Board Commission on Precollege Mathematics, Science, and Technology Education, 1983; Task Force on Education for Economic Growth, 1983; Twentieth Century Fund, 1983). The poor performance of American students on international assessments in science and mathematics and the relatively low amount of instruction in these subjects for the average American student were frequently cited in the reports as evidence of the fundamental problems in our schools and as a rationale for proposed education reforms. *A Nation at Risk* recommended three mathematics and three science courses be required for high school graduation and that science be made a "new basic" in elementary school.

Many of the state reforms in the 1980s were aimed at setting higher standards for the amount of mathematics and science instruction in schools. From 1980 to 1987, 43 states increased mathematics course requirements for graduation, and 40 states increased science requirements (Education Commission of the States, 1984, 1987; Blank and Espenshade, 1988b). By 1987, 26 states had a state policy giving direction or recommendations to schools on the amount of time to be spent on elementary science and mathematics (Blank and Espenshade, 1988b).

In a 1988 report on science and mathematics indicators, the National Research Council recommended the development and use of indicators of the amount of instructional time spent on elementary science and mathematics and secondary course enrollments in science and mathematics (Murnane and Raizen). These indicators would not measure time elementary students are engaged in learning in science and math, nor would they measure the content of science and mathematics curriculum students are taught. However, they do represent important differences in student opportunities for learning science and math. Elementary instructional time has been shown to be positively related to student achievement, especially in mathematics because few students learn mathematics outside of school (Husen, 1967; McKnight, 1987). Instructional time in these subjects has also been shown to vary considerably by school and teacher (Goodlad, 1984; Weiss, 1987). Research with large national surveys and international surveys (e.g., National Assessment of Education Progress, National Longitudinal Study, High School and Beyond, and Second International Mathematics Study) has demonstrated the importance of student course taking in science and mathematics for student learning (Jones, et al., 1986; Dossey, et al., 1988; Mullis, et al., 1988; Rock, et al., 1985; McKnight, et al., 1987).

National Studies. Analyses of student course enrollments from transcripts of a national sample of students in 1982 and 1987 show that course taking in science and mathematics has been increasing. The average number of credits earned in mathematics increased from 2.4 to 2.98, and the average number of credits in science increased from 2.19 to 2.63, which is an increase of half a credit in each subject (ETS, 1989; Kolstad and Thorne, 1989). These increases appear to affirm that higher state graduation requirements did produce increased study in science and mathematics, since many of the states raised graduation requirements from 1983 to 1985 effective for the class of 1987, 1988, or 1989.

Studies of State Reforms. Recent research on state reforms has analyzed course offerings and student participation in relation to state policies. State level studies show that increases in course enrollments are related to state policies, but the increases vary by course level. Policy Analysis for California Education (PACE), a consortium of university scholars, conducted a study of change in course enrollments related to California policy changes in graduation requirements (Cagampang and Guthrie, 1988). The PACE study found that in California the increased requirements for graduation produced enrollment increases of 27 percent in science, one percent in math, and 21 percent in foreign languages. In the same period, enrollments in vocational courses and other electives declined. The Center for Policy Research in Education (CPRE), supported by the U.S. Department of Education, studied district implementation of curriculum reforms in science and mathematics in six states, and analyzed student course taking in science and mathematics (Clune, 1989). The CPRE study showed that rates of course taking increased following reforms, but the largest increases were in lower level science and mathematics courses.

A more in-depth approach to analyzing the relationship of state curriculum reforms and the implemented curriculum involves identifying the curriculum content or topics that are actually taught in schools and classrooms. One method is through an "opportunity-to-learn" survey with teachers and students, as used in IEA studies (McKnight, et al., 1987). With data on students' opportunity-to-learn the curriculum topics included in achievement tests, the implemented curriculum can be related to student achievement scores. A new study by McDonnell, et al. (1990) recommends augmenting course enrollment data with teacher and student surveys to collect data on instructional activities, topic coverage and treatment, textbook usage, and other information. The study also recommends use of periodic benchmark data from interviews, student transcripts, and course materials that would validate more regularly reported coursework indicators.

Another method of analyzing curriculum content in science and mathematics is being tested in a study, "Reform Up Close," supported by the National Science Foundation. The Center for Policy Research in Education is currently conducting a detailed study of changes in science and mathematics course taking and curriculum content in a sample of schools and classrooms in six states. Teacher logs are being used to collect data on curriculum topics and teaching methods used in a sample of classrooms. CCSSO is working with a task force of state specialists and education researchers to plan and pilot test state level indicators of curriculum content in science and math.

This report presents state level data on two types of indicators of instructional time and student participation in science and mathematics curricula: (a) secondary course enrollments in science and math, and (b) elementary class time spent on science and math. The course enrollment data were reported by states for the 1989–90 school year. The data on elementary class time were collected from teachers in the 1988 Schools and Staffing Survey of NCES. The statistics in this report give a one year snapshot of the indicators. As the indicators system provides periodic data on these indicators, CCSSO will be able to analyze trends in instructional time and participation in science and math.

Science And Mathematics Course Enrollments

CCSSO collected state total enrollments for all science and mathematics course taking in grades 7–12. The data categories are based on a course level hierarchy for science and math, e.g., basic, regular, advanced courses, as well as important subject differences, e.g., biology, chemistry, physics, and general math, algebra, geometry. Tables 1 and 2 display state-by-state data on course taking in selected gatekeeping courses in high school.

High School Mathematics Course Taking. Table 1 shows the proportion of public high school students that are estimated to take mathematics at three levels by the time they graduate: algebra 1 (formal mathematics level 1), algebra 2 (level 3), and calculus (level 5). For purposes of state-by-state comparisons, the CCSSO course enrollment reporting plan divided all the high school mathematics courses into three categories, (review, informal, and formal mathematics), and each category has from one to five levels for classifying courses. The most frequently reported course under formal mathematics level 1 is algebra 1; the most common course under level 3 is algebra 2. Categorization of courses by levels allows comparison of mathematics enrollments among states using a standard taxonomy, and it incorporates the trend in mathematics education toward integrated courses (CCSSO, 1989b, see Appendix D).

From 1982 to 1987, the percentage of high school graduates that took algebra 1 increased from 65 percent to 77 percent, algebra 2 enrollments increased from 35 to 46 percent, and calculus enrollments increased from 4.7 to 6.1 percent, according to data from national representative samples of graduates (Westat, 1988; Kolstad & Thorne, 1989). Algebra 1 (formal mathematics level 1) is a gatekeeper course for students who wish to complete a "formal mathematics" sequence in high school. The enrollment in algebra 2 (level 3) measures the proportion of students that reach the third level of formal mathematics. Calculus (level 5) is a gatekeeper course for students intending to major in science or mathematics in college.

The national totals and estimated state percentages in Table 1 are based on the population of public high school students in each state.[1]

Estimated Percent of U.S. Students Taking Mathematics at Three Levels	
Algebra 1	81%
Algebra 2	49
Calculus	9

The state percentages for algebra 1 vary from over 95 percent (Louisiana, New Mexico) to 52 percent (Hawaii). State

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[1] Each state percentage is a statistical estimate of course taking of high school students by the time they graduate, based on the total course enrollment in grades 9–12 in Fall 1989 (see Appendix Table A-5) divided by the number of students in a grade cohort during four years of high school. The denominator estimates were computed from the state's 1989 student membership per grade (NCES' Common Core of Data) multiplied by a regional average for science/math course-taking at each grade level from the NCES 1987 National Transcript Study (Westat, 1988). See Appendix C for further explanation.

Table 1
ESTIMATED PROPORTION OF PUBLIC SCHOOL STUDENTS TAKING SELECTED MATHEMATICS COURSES BY GRADUATION

STATE	ALGEBRA 1 (Formal Math Level 1)	ALGEBRA 2 (Formal Math Level 3)	CALCULUS (Formal Math Level 5)
ALABAMA	70%	46%	6%
ALASKA	—	—	—
ARIZONA	—	—	—
ARKANSAS	88	48	5
CALIFORNIA	92	44	9
COLORADO	—	—	—
CONNECTICUT	74	61	14
DELAWARE	73	43	17
DC	65	39	3
FLORIDA	78	42	9
GEORGIA	—	—	—
HAWAII	52	33	4
IDAHO	95+	64	6
ILLINOIS	77	39	9
INDIANA	60	45	8
IOWA	92	50	9
KANSAS	66	47	9
KENTUCKY	81	54	6
LOUISIANA	95+	64	4
MAINE	84	64	—
MARYLAND	94	51	13
MASSACHUSETTS	—	—	—
MICHIGAN	—	—	—
MINNESOTA	90	55	12
MISSISSIPPI	85	58	3
MISSOURI	95	58	8
MONTANA	94	65	6
NEBRASKA	75	54	6
NEVADA	90	32	5
NEW HAMPSHIRE	—	—	—
NEW JERSEY	—	—	—
NEW MEXICO	95+	47	8
NEW YORK	69	46	12
NORTH CAROLINA	67	51	8
NORTH DAKOTA	95	64	3
OHIO	80	47	8
OKLAHOMA	95+	60	8
OREGON	—	—	—
PENNSYLVANIA	88	57	16
RHODE ISLAND	—	—	—
SOUTH CAROLINA	69	55	7
SOUTH DAKOTA	—	—	—
TENNESSEE	79	54	4
TEXAS	82	54	5
UTAH	82	63	13
VERMONT	—	—	—
VIRGINIA	81	55	11
WASHINGTON	—	—	—
WEST VIRGINIA	73	42	2
WISCONSIN	79	36	9
WYOMING	73	29	8
U.S. TOTAL	81%	49%	9%

Note: Each state proportion is a statistical estimate of course taking of high school students by the time they graduate based on the total course enrollment in grades 9-12 in Fall 1989 (See Appendix Table A-5) divided by the estimated number of students in a grade cohort during four years of high school. The statistical estimating method is imprecise above 95 percent course taking rate. (see Appendix C for further explanation)

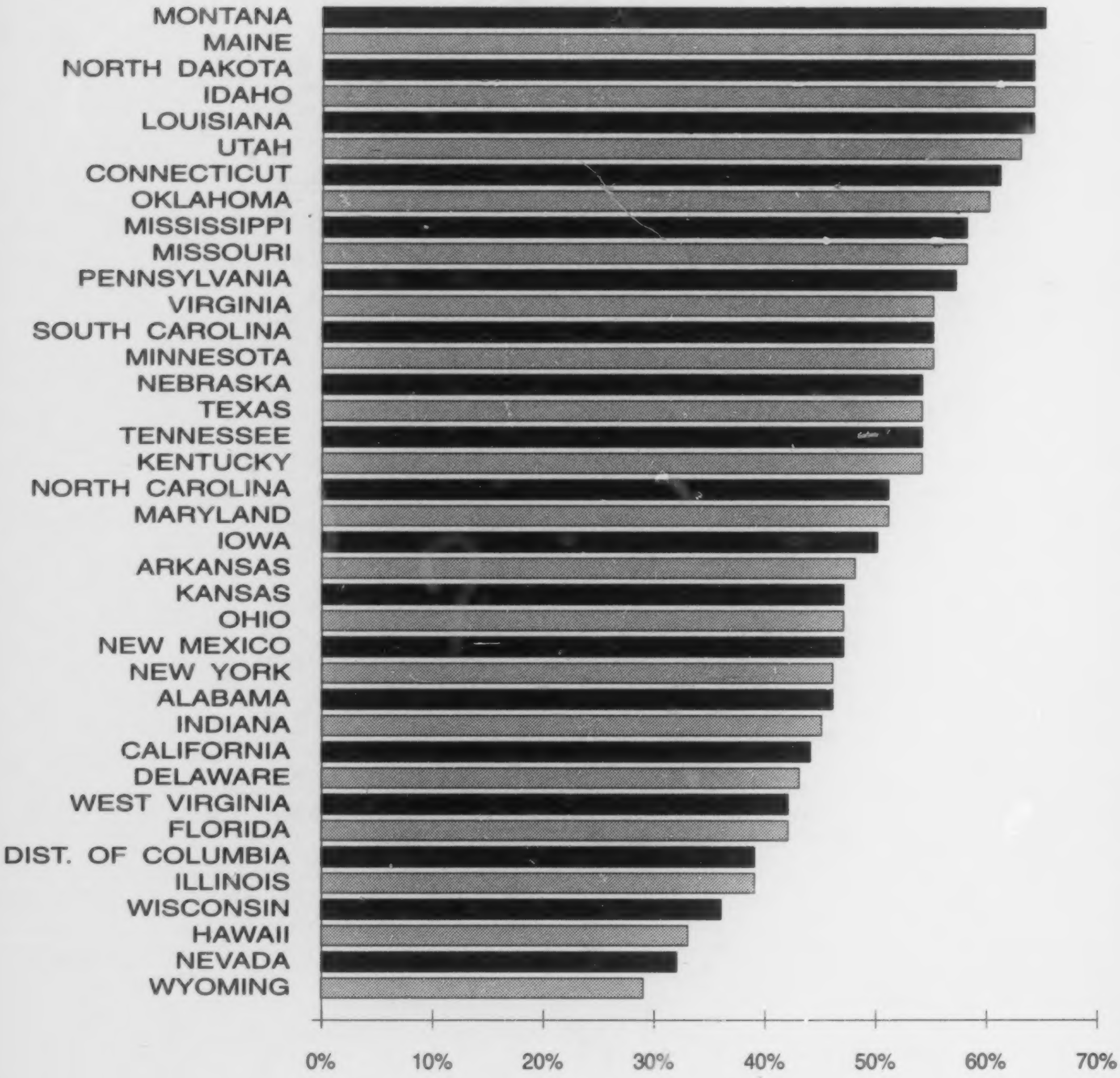
Algebra 1 percentages include grade 8.

—Data not available

U.S. Total=Proportion of all high school students estimated to take each course, including imputation for non-reporting states.

Source: State Departments of Education, Data on Public Schools, Fall 1989; N. Carolina and Wisconsin, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Figure 2
Estimated Proportion of Public High School Students Taking Algebra 2



Percent of students taking algebra 2 by graduation (38 States)
U.S. Total = 49%

Source: State Departments of Education, Data on Public Schools, Fall 1989
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

percentages for algebra 2 vary from 65 percent (Montana) to 33 percent (Hawaii), and for calculus from 17 percent (Delaware) to 3 percent (D.C., Mississippi, North Dakota).

The wide variation in state percentages for algebra 1 and 2 can be attributed to a number of factors, including differences in state requirements for graduation and differences in state curriculum organization and emphasis. For example, Hawaii has 52 percent of students taking algebra 1, but almost all students take a review or informal mathematics course during high school (see Appendix Table A-4). The high proportion of students taking algebra 1 in Louisiana can be attributed to a state policy requiring that algebra 1 be passed for high school graduation.[2]

Algebra 2 (formal mathematics level 3) is a gatekeeper course for students pursuing more advanced study in science and mathematics in high school and college. The state proportions of graduates taking algebra 2 (formal mathematics level 2) are rank-ordered in a histogram in Figure 2.

Comparing the 1989 state data on mathematics course taking with the 1987 national transcript results, 24 of the 38 reporting states have higher proportions taking algebra 1 than the national average in 1987 (77%). In algebra 2, 25 states are above the 1987 national average (46%), and in calculus, 22 states are above the 1987 national average (6.1%). The state-by-state data confirm the findings from the 1982 and 1987 transcript studies showing increasing enrollments in mathematics in the 1980s.

High School Science Course Taking. The CCSSO data reporting on science included four course levels in biology, chemistry, physics, and earth science: basic/applied, general, second year/advanced, and advanced placement. Course enrollments were also collected for physical science and general science (see Appendix D for course categories). Table 2 shows national and state-by-state statistics on the estimated proportion of public high school students that take three key science courses by the time they graduate. Biology is the course taken by most high school students, chemistry is a gatekeeper for continuing study in science fields, and physics enrollments indicate the proportion of students completing a high school science curriculum. The percentages taking first year courses shown in Table 2 include enrollments in general and basic, or applied, courses. The national state totals and percentages are based on the population of public high school students in each state.

Estimated Percent of U.S. Students Taking Science at Three Levels	
Biology	95+%
Chemistry	45
Physics	20

These results for science are consistent with findings from national transcript studies that rates of course taking increased in 1980s as state requirements increased. Transcript data from national samples of graduates showed that the percent taking biology increased from 75 percent in 1982 to 90 percent in 1987, chemistry increased from 31 percent to 45 percent, and physics increased from 14 percent to 20 percent (Kolstad & Thorne, 1989).

In 17 states the proportion of students taking first year biology is over 95 percent. In many states, the change to a graduation requirement of two course credits in science means that the typical student takes an introductory (9th grade) course in earth science, general science, or physical science, and the second course is first year biology. In a few states, such as Mississippi, biology is generally the first science course that is taken in high school. In sum, a first year biology course has become common to the curriculum of almost all high school students.

In many states, students take a basic biology course to meet their science requirement. The first year biology percentages include enrollments in general biology courses as well as basic biology courses. Twenty-one states reported separate course taking totals for these two categories (see Appendix Table A-9), and the state median was 18 percent of first year biology enrollments in basic biology courses.

Figure 3 shows a histogram of state percentages of graduates taking first year chemistry. The range of state enrollments in chemistry is from 62 percent (Connecticut) to 33 percent (Arkansas, Nevada, New Mexico). Eighteen of 38 reporting states had higher rates of enrollment than the national percentage taking chemistry in 1987 (45%). In first year physics, the state percentages vary from 36 percent (Connecticut) to 11 percent (Tennessee). Only 14 reporting states had rates of physics enrollments that are higher than the 1987 national rate (20%).

State data on course enrollments in all high school math, science, and computer science courses reported to CCSSO are listed in Appendix Tables A-1 through A-9.

High School Course Enrollments by Grade. Another way of analyzing secondary course enrollments in science and mathematics is to consider the grade levels at which students take courses. High school students planning to enter college study in fields of science or mathematics generally begin a sequence of courses in eighth or ninth grade. States, districts, or schools can examine the enrollment patterns of students in science and mathematics by grade to determine the point at which most students are taking courses. Regularly reported enrollment data can be used to track change in the proportion of students taking gatekeeper courses early in the secondary grades.

CCSSO requested that states report course enrollments by *student grade* if the data were available. Seven states had the data available and reported grade-by-grade data for Fall 1989. Table 3 shows the enrollment percentages by grade for two courses taken by a majority of high school students: first

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[2] It should be reiterated that state differences in course taking are a measure of the relative level of participation in the mathematics and science curriculum and not a measure of state differences in curriculum content.

Table 2

ESTIMATED PROPORTION OF PUBLIC HIGH SCHOOL STUDENTS TAKING SELECTED SCIENCE COURSES BY GRADUATION

STATE	BIOLOGY 1st Year	CHEMISTRY 1st Year	PHYSICS 1st Year
ALABAMA	95+%	38%	21%
ALASKA	—	—	—
ARIZONA	—	—	—
ARKANSAS	95+	33	13
CALIFORNIA	91	33	16
COLORADO	—	—	—
CONNECTICUT	95+	62	36
DELAWARE	95+	48	19
DC	75	46	13
FLORIDA	95+	44	19
GEORGIA	—	—	—
HAWAII	88	40	21
IDAHO	80	26	15
ILLINOIS	78	40	20
INDIANA	95+	42	19
IOWA	95+	57	27
KANSAS	95+	45	17
KENTUCKY	95+	45	14
LOUISIANA	90	50	21
MAINE	94	58	—
MARYLAND	95+	61	27
MASSACHUSETTS	—	—	—
MICHIGAN	—	—	—
MINNESOTA	95+	44	23
MISSISSIPPI	95+	55	17
MISSOURI	86	41	16
MONTANA	95+	48	24
NEBRASKA	95+	46	21
NEVADA	65	33	13
NEW HAMPSHIRE	—	—	—
NEW JERSEY	—	—	—
NEW MEXICO	95+	33	15
NEW YORK	95+	56	28
NORTH CAROLINA	95+	47	15
NORTH DAKOTA	95+	54	24
OHIO	95+	49	20
OKLAHOMA	93	37	10
OREGON	—	—	—
PENNSYLVANIA	95+	56	29
RHODE ISLAND	—	—	—
SOUTH CAROLINA	95+	51	16
SOUTH DAKOTA	—	—	—
TENNESSEE	88	42	11
TEXAS	95+	40	12
UTAH	80	37	20
VERMONT	—	—	—
VIRGINIA	95+	57	23
WASHINGTON	—	—	—
WEST VIRGINIA	95+	40	11
WISCONSIN	95+	51	25
WYOMING	86	36	16
U.S. TOTAL	95+%	45%	20%

Note: Each state proportion is a statistical estimate of course taking of high school students by the time they graduate based on the total course enrollment in grades 9–12 in Fall 1989 (See Appendix Table A-6) divided by the estimated number of students in a grade cohort during four years of high school. The statistical estimating method is imprecise above 95 percent course taking rate. (see Appendix C for further explanation)

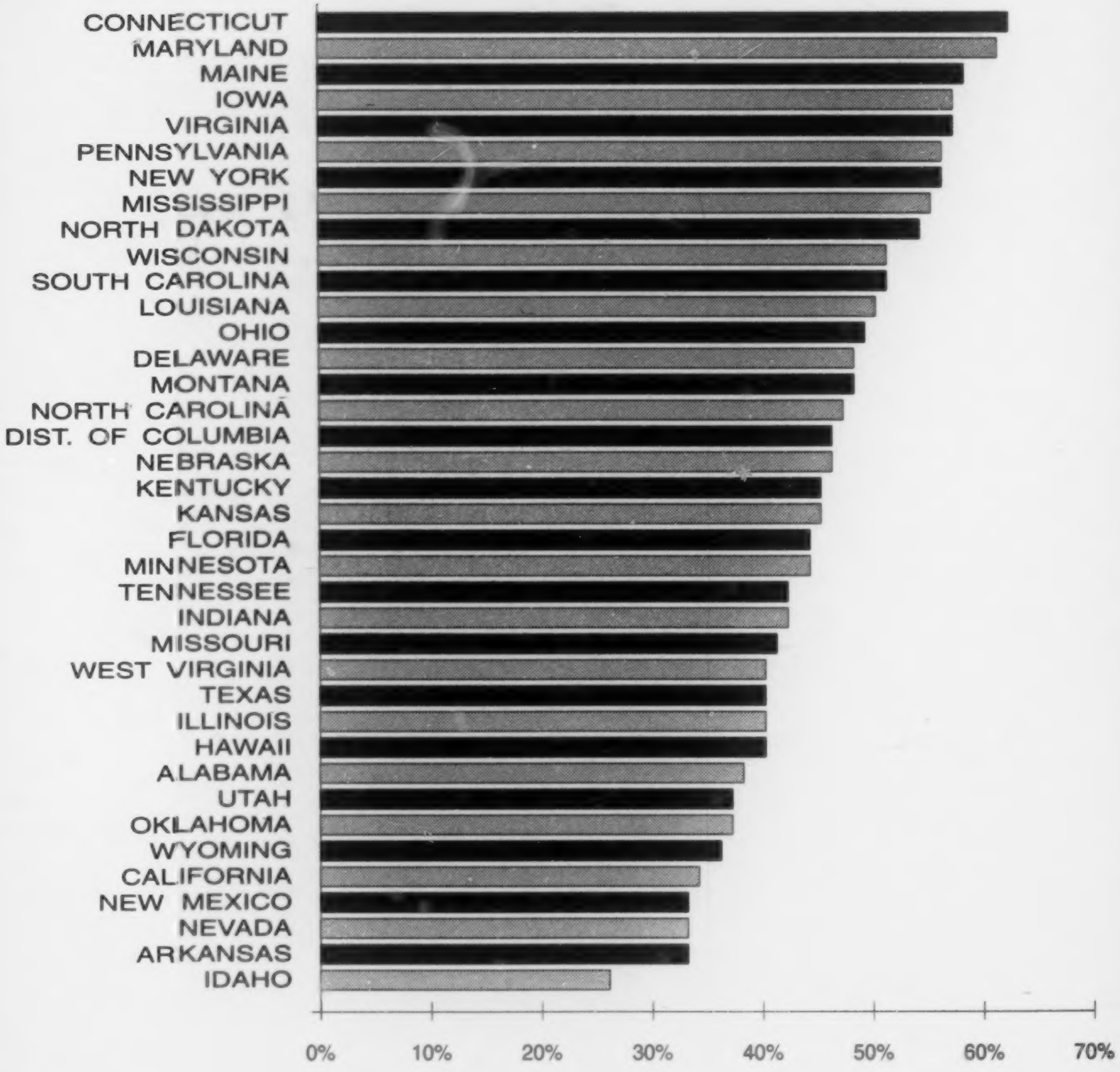
—Data not available

U.S. Total=Proportion of all high school students estimated to take each course, including imputation for non-reporting states.

Source: State Departments of Education, Data on Public Schools, Fall 1989; N. Carolina and Wisconsin, Fall 1988

Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Figure 3
Estimated Proportion of Public High School Students Taking First Year Chemistry



Percent of students taking first year chemistry by graduation (38 States)
U.S. Total = 45%

Source: State Departments of Education, Data on Public Schools, Fall 1989
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Table 3
PERCENT OF STUDENTS IN EACH GRADE TAKING ALGEBRA 1 AND FIRST YEAR BIOLOGY
(October 1989)

ALGEBRA 1 (Formal Math Level 1)

	Percent of Grade 8	Percent of Grade 9	Percent of Grade 10	Percent of Grade 11	Percent of Grade 12	Estimated Percent by Graduation (Table 1)
ALABAMA	7%	44%	15%	2%	1%	70%
CALIFORNIA	13	42	28	4	2	92
CONNECTICUT	15	40	12	5	2	74
FLORIDA	11	26	24	12	7	78
HAWAII	6	16	16	11	5	52
NORTH DAKOTA	—	70	18	5	2	95
WISCONSIN	—	39	25	12	4	79

BIOLOGY, First Year

	Percent of Grade 9	Percent of Grade 10	Percent of Grade 11	Percent of Grade 12	Estimated Percent by Graduation (Table 2)
ALABAMA	25%	70%	6%	2%	95+%
CALIFORNIA	12	65	8	4	91
CONNECTICUT	20	65	8	5	95+
FLORIDA	23	68	6	3	95+
HAWAII	18	59	10	3	88
NORTH DAKOTA	2	95	5	1	95+
WISCONSIN	19	68	7	3	95+

—Data not available.
Source: State Departments of Education, Data on Public Schools, Fall 1989; Wisconsin, Fall 1988.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990.

year biology and algebra 1 (formal mathematics level 1). The state data show that most students take first year biology in grade 10—at least 64 percent in the seven states. Students that expect to take a science-sequence of first year biology, chemistry, physics, and an advanced/second-year course in one field would take biology in ninth grade. In five states more than 20 percent of students take biology in grade 9. Biology enrollments in grades 11 and 12 vary from three to eight percent.

A majority of students take algebra 1 in grade 9, and there is wide variation among the seven states, with three states over 70 percent, two over 50 percent, and Hawaii and Florida at 32 and 39 percent, respectively. Hawaii and Florida have high rates of enrollment in review and informal mathematics (e.g., general mathematics and pre-algebra) (Appendix Table A-4), and these rates may be related to the low rates for algebra 1 in grade 9. States with high ninth grade algebra enrollments tend to have more students taking upper level mathematics courses. Connecticut has 70 percent of ninth grade students taking algebra 1 and high proportions of high school students taking algebra 2 (61%) and calculus (14%) (from Table 1). North Dakota has 75 percent of ninth grade students taking algebra 1, and 64 percent taking algebra 2, and 3 percent taking calculus. Alabama has 74 percent taking algebra 1 in ninth grade, but only an average proportion of students taking upper level mathematics (46 percent in algebra 2, 6 percent in calculus).

Algebra and Accelerated Mathematics in Grade 8. To complete a five course college preparatory mathematics sequence ending in calculus by high school graduation, students generally need to take algebra 1 in eighth grade. The level of mathematics being taught in eighth grade is of particular interest because the Second International Mathematics Study showed that the proportion of U.S. students being taught algebra in eighth grade was a major contributor to low U.S. achievement scores in mathematics (McKnight, 1987). The state-by-state indicators system included state reported data on mathematics and science course enrollments in grades 7 and 8, with mathematics reported in three categories: regular mathematics, accelerated mathematics, and algebra 1. Table 4 lists the percentages of students taking algebra 1 and accelerated mathematics in grade 8. Accelerated mathematics is defined as a pre-algebra course that includes instruction in some algebra topics (McKnight, 1987; CCSSO, 1989b).

The data show that state enrollments in algebra 1 in grade 8 vary from 24 percent (Maryland) to 3 percent (Arkansas). Several states with more students taking algebra 1 in grade 8 (e.g., Connecticut, Delaware, and Maryland) have higher proportions of high school students taking upper level mathematics courses (see Table 1). Results from the Second International Mathematics Study showed that 13 percent of U.S. eighth grade students were enrolled in algebra 1 or a higher level course (Travers, et al, 1986). The state data are not sufficiently representative to compute a national total. However, among 21 states, 11 percent of eighth grade students were taking algebra 1 in 1989.

State enrollments in accelerated mathematics in grade 8 vary from 27 percent (Nebraska) to one percent (Louisiana), and the median state has 11 percent enrolled.

States showing totals for only accelerated mathematics, and not algebra 1, such as D.C., Kansas, Nebraska, New York, and North Carolina combined data on eighth grade algebra 1 and accelerated mathematics under one category (accelerated mathematics).

Table 4

PERCENT OF STUDENTS IN GRADE 8 TAKING ACCELERATED MATHEMATICS AND ALGEBRA 1

(October 1989, Public Schools)

STATE	Total Students Grade 8	ACCELERATED Grade 8 Math	ALGEBRA 1 Grade 8	ACCELERATED MATH OR ALGEBRA 1
ALABAMA	54,912	5%	7%	12%
ALASKA	7,572	—	—	—
ARIZONA	42,172	—	—	—
ARKANSAS	33,353	—	3%	3%
CALIFORNIA	330,967	3%	13%	16%
COLORADO	39,697	—	—	—
CONNECTICUT	31,127	19%	16%	35%
DELAWARE	6,934	9%	20%	29%
DIST OF COLUMBIA	5,119	23%	—	23%
FLORIDA	127,763	15%	11%	26%
GEORGIA	82,504	—	—	—
HAWAII	11,177	.3%	6%	6%
IDAHO	16,187	11%	12%	23%
ILLINOIS	122,583	1%	7%	8%
INDIANA	70,229	—	—	—
IOWA	33,143	—	—	—
KANSAS	30,189	16%	—	16%
KENTUCKY	46,242	—	11%	11%
LOUISIANA	54,975	1%	5%	6%
MAINE	14,917	—	—	—
MARYLAND	46,629	—	24%	24%
MASSACHUSETTS	58,141	—	—	—
MICHIGAN	106,260	—	—	—
MINNESOTA	51,830	—	6%	6%
MISSISSIPPI	36,019	—	7%	7%
MISSOURI	58,052	—	10%	10%
MONTANA	10,917	—	—	—
NEBRASKA	19,116	27%	—	27%
NEVADA	13,198	16%	7%	23%
NEW HAMPSHIRE	12,058	—	—	—
NEW JERSEY	72,607	—	—	—
NEW MEXICO	19,768	8%	8%	16%
NEW YORK	171,331	9%	—	9%
NORTH CAROLINA	79,280	11%	—	11%
NORTH DAKOTA	8,504	13%	—	13%
OHIO	128,241	—	9%	9%
OKLAHOMA	40,762	—	7%	7%
OREGON	35,253	—	—	—
PENNSYLVANIA	115,963	—	—	—
RHODE ISLAND	9,388	—	—	—
SOUTH CAROLINA	45,691	—	13%	13%
SOUTH DAKOTA	9,275	—	—	—
TENNESSEE	58,576	—	—	—
TEXAS	238,057	—	—	—
UTAH	32,563	—	—	—
VERMONT	6,746	—	—	—
VIRGINIA	70,040	—	—	—
WASHINGTON	56,617	—	—	—
WEST VIRGINIA	25,292	12%	8%	20%
WISCONSIN	51,757	7%	—	7%
WYOMING	6,959	—	20%	20%
MEDIAN		11%	8%	13%
TOTAL (28 states)			11%	14%

Total=Sum of students taking the course in reporting states; Median=Median state percentage taking course.

Notes: States not reporting Algebra 1 for Grade 8 generally include Algebra 1 under Accelerated Math for state data collection. Percentages based on state course enrollment data; math taught in self-contained classrooms not included.

—Data not available.

Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina and Wisconsin, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

The enrollment rate of eighth grade students taking either algebra 1 or accelerated mathematics is shown in the far right column in Table 4. The state percentages for eighth grade algebra 1 or accelerated mathematics vary from 34 percent (Connecticut) to three percent (Arkansas). Among the 28 states reporting eighth grade data, a total of 13 percent of students are taking an algebra or accelerated mathematics course. Since this total is based on only 28 states and does not include enrollments for several large states, such as Pennsylvania and Texas, the 13 percent statistic should be considered preliminary until more complete data are available.

In 1988, the National Education Longitudinal Study (NELS) surveyed a nationally representative sample of eighth grade students and their teachers, and 29 percent of the students reported "attending an algebra or advanced mathematics class" (Horn and Hafner, 1990).[3] A question in NELS asked about topic coverage in math, and the results showed that the content of teaching in algebra and advanced/accelerated classes differed markedly from general and remedial classes by offering much greater intensity of instruction in algebra and problem solving.

State-by-state data on course taking in grades 7 and 8 in science and mathematics are listed in Appendix Tables A-10 and A-11.

Enrollments in Advanced Courses. State data on student enrollments in advanced mathematics and science courses provide an indicator of the proportion of students preparing for college majors in scientific fields. The data in Table 1 showed state enrollments in calculus, and Table 2 showed enrollments in first year chemistry and physics. Another available indicator is the proportion of students taking advanced placement (AP) mathematics and science courses and other advanced or second year science courses. Since advanced placement courses use a standard curriculum, state enrollment figures provide a comparable measure of advanced instruction in a course.

Table 5 shows state-by-state data on enrollments in advanced placement and second year other advanced courses. The total enrollments across 36 states, expressed as a percent of 12th grade students, are:

Percent of U.S. 12th Grade Students Taking Advanced Courses

	Advanced Placement	Second Year/ Other Advanced
Calculus	2%	7%
Biology	2	16
Chemistry	1	3
Physics	.5	1
Earth Science	—	4

Only 20 of the 35 reporting states separately collected data on advanced placement courses. The other states collect data on one advanced category, e.g., advanced biology. Thus, AP enrollments could not be analyzed in 15 states. The CCSSO course category taxonomy defined other advanced in science as a course that has a prerequisite of a first year course in the field.[4]

In Table 5, Alabama reports three percent taking AP calculus. This percentage means that 1,300 of over 43,000 12th graders took AP calculus. States with high enrollments in AP calculus are Connecticut, Maryland, New York, South Carolina, and Virginia. The 1987 transcript study of a national sample of graduates showed that three percent of graduates took AP calculus.

Idaho, Kansas, Nevada, Wisconsin, and Wyoming had high enrollments in AP biology. Kentucky reported that three percent of students took AP biology, which represents 1,200 of over 40,000 12th graders. Mississippi, Florida, Missouri, and Kentucky had enrollments in second year/advanced biology which represent over one fourth of 12th graders in those states. Mississippi's high percentage (76%) is due to students taking first year biology as the first high school science course, and the majority taking a second biology course to meet the two credit state graduation requirement. The 1987 national transcript study reported that three percent of graduates took AP or honors biology.

Delaware, Indiana, Minnesota, Missouri, Pennsylvania, and Wisconsin had high enrollments in AP or advanced chemistry (over six percent). The nine percent enrollment in Missouri means that 4,700 of 52,000 12th graders took an advanced chemistry course. Delaware, Minnesota, and Wisconsin had high enrollments in AP or advanced chemistry (over six percent). The nine percent enrollment in Missouri means that 4,700 of 52,000 12th graders took an advanced chemistry course. Delaware, Minnesota, and Wisconsin had high enrollments in AP or advanced physics. The three percent enrollment in Minnesota means that 1,600 of 53,000 12th graders took an advanced physics course. The 1987 national transcript study reported that 3.1 percent of graduates took AP or honors chemistry and 1.8 percent of graduates took AP or honors physics.

Elementary Class Time on Science and Mathematics

The amount of class time spent on science and mathematics in elementary schools was selected as a priority state indicator. Many states have an interest in this indicator because of the state role in defining curriculum goals and expected time in instruction. CCSSO's 1987 survey showed that 38 states have curriculum frameworks or guidelines in science and mathematics, and 26 states recommend or

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[3] This is a different measure than the state indicator which is based on school- and teacher-reported enrollments in courses designated as algebra and accelerated mathematics.

[4] For purposes of comparison across states, state student membership for grade 12 was used as the denominator for computing percentages, understanding that some students take advanced courses prior to grade 12.

Table 5

STUDENTS TAKING SECOND YEAR/ADVANCED COURSES AS A PERCENT OF STUDENTS IN GRADE 12 (October 1989, Public Schools)

STATE	Students Grade 12	CALCULUS		BIOLOGY		CHEMISTRY		PHYSICS		EARTH SCIENCE
		Adv. Place.	Reg.	Adv. Place	Other Adv.	Adv. Place.	Other Adv.	Adv. Place.	Other Adv.	Advanced
ALABAMA	43,482	3%	3%	5%	14%	2%	—	1%	—	.2%
ALASKA	6,402	—	—	—	—	—	—	—	—	—
ARIZONA	35,618	—	—	—	—	—	—	—	—	—
ARKANSAS	28,505	—	5%	—	—	—	—	—	—	—
CALIFORNIA	243,023	—	9%	—	14%	—	3%	—	2%	3%
COLORADO	34,799	—	—	—	—	—	—	—	—	—
CONNECTICUT	29,186	5%	8%	2%	14%	1%	2%	1%	1%	9%
DELAWARE	6,314	4%	13%	2%	12%	1%	6%	1%	2%	2%
DIST OF COLUMBIA	3,778	—	4%	4%	.7%	3%	—	.7%	—	.4%
FLORIDA	96,639	4%	4%	2%	47%	1%	0%	1%	.3%	11%
GEORGIA	59,445	—	—	—	—	—	—	—	—	—
HAWAII	9,453	4%	.2%	.2%	5%	2%	0%	.7%	—	18%
IDAHO	13,149	3%	3%	8%	9%	—	.5%	2%	.8%	14%
ILLINOIS	110,514	1%	8%	—	14%	—	4%	—	.9%	2%
INDIANA	65,063	—	8%	—	22%	—	9%	—	2%	5%
IOWA	33,795	—	9%	—	8%	—	—	—	—	—
KANSAS	26,918	3%	6%	7%	14%	1%	2%	.4%	.3%	1%
KENTUCKY	40,186	4%	2%	3%	29%	1%	5%	.6%	.5%	—
LOUISIANA	41,604	1%	3%	1%	7%	7%	1%	.5%	.1%	.5%
MAINE	14,552	—	—	—	—	—	—	—	—	—
MARYLAND	43,302	6%	6%	5%	16%	3%	2%	2%	.4%	4%
MASSACHUSETTS	60,588	—	—	—	—	—	—	—	—	—
MICHIGAN	97,713	—	—	—	—	—	—	—	—	—
MINNESOTA	53,724	—	12%	—	14%	—	8%	—	3%	2%
MISSISSIPPI	27,851	2%	1%	1%	76%	.4%	6%	.2%	.3%	1%
MISSOURI	52,420	—	8%	—	38%	—	9%	—	2%	9%
MONTANA	9,961	.2%	5%	.5%	17%	0%	3%	0%	2%	3%
NEBRASKA	19,099	—	6%	—	18%	—	—	—	—	—
NEVADA	11,297	.5%	4%	6%	2%	2%	2%	.2%	—	—
NEW HAMPSHIRE	11,131	—	—	—	—	—	—	—	—	—
NEW JERSEY	70,438	—	—	—	—	—	—	—	—	—
NEW MEXICO	15,751	3%	6%	—	11%	—	—	—	—	4%
NEW YORK	148,836	9%	3%	4%	5%	2%	.6%	2%	.1%	3%
NORTH CAROLINA	68,194	—	8%	—	17%	—	3%	—	.3%	4%
NORTH DAKOTA	8,032	—	3%	—	20%	—	4%	—	—	2%
OHIO	125,373	—	8%	—	11%	—	—	—	—	3%
OKLAHOMA	37,728	—	8%	—	3%	—	3%	—	.4%	1%
OREGON	30,018	—	—	—	—	—	—	—	—	—
PENNSYLVANIA	115,400	4%	12%	—	15%	—	7%	—	2%	4%
RHODE ISLAND	8,346	—	—	—	—	—	—	—	—	—
SOUTH CAROLINA	36,621	5%	2%	3%	9%	1%	3%	.2%	.2%	.4%
SOUTH DAKOTA	8,248	—	—	—	—	—	—	—	—	—
TENNESSEE	50,851	—	4%	2%	9%	.9%	1%	.5%	—	—
TEXAS	192,963	—	5%	—	12%	—	2%	—	1%	10%
UTAH	24,971	—	—	—	—	—	—	—	—	—
VERMONT	5,719	—	—	—	—	—	—	—	—	—
VIRGINIA	63,501	6%	6%	4%	12%	2%	2%	.9%	.7%	4%
WASHINGTON	53,840	—	—	—	—	—	—	—	—	—
WEST VIRGINIA	22,831	—	4%	1%	30%	—	5%	—	.1%	—
WISCONSIN	56,022	—	9%	10%	12%	5%	4%	2%	2%	4%
WYOMING	6,281	3%	5%	8%	12%	1%	2%	0%	.4%	1%
TOTAL (36 states)		2%	7%	2%	16%	1%	3%	.5%	1%	4%

—Data not available.
Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina and Wisconsin, Fall 1988
Council Of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990.

mandate time to be spent on elementary mathematics and science (Blank and Espenshade, 1988b). National statistics have been reported for this indicator. The 1985–86 survey of a national sample of elementary teachers showed that the average teacher in kindergarten through grade three spent 19 minutes per day on science and 38 minutes on mathematics; and the average teacher in grades 4–6 spent 38 minutes on science and 49 minutes on mathematics (Weiss, 1987).

State-by-state data on elementary class time are available from the Schools and Staffing Survey of 1988 and the results are in Table 6. The Survey was conducted with national- and state-representative sample of teachers. Elementary teachers were asked how much time was spent per week on four core subjects.[5]

The class time spent on science in grades 1–3 varies by state from 1.3 hours per week (Rhode Island) to 3.5 hours (Texas), and in grades 4–6 from 2.2 hours per week (Utah) to 4.1 hours (New Hampshire).

The time spent on mathematics/arithmetic in grades 1–3 varies from 4.2 hours per week (Ohio) to 6.0 hours (D.C.), and in grades 4–6 from 4.1 hours (Ohio) to 5.5 hours (Hawaii, Tennessee).

For purposes of comparison, the median amount of elementary class time spent on social studies/history is 2.6 hours per week in grades 1–3 and 3.4 hours per week in grades 4–6. The median class time spent on English/language arts is 11.9 hours per week in grades 1–3 and 9.5 hours per week in grades 4–6.

Elementary Science and Mathematics Hours Per Week (Median State)

	Science	Mathematics
Grades 1–3	2.3 hours (27 mins/day)	4.8 hours (57 mins/day)
Grades 4–6	3.0 hours (36 mins/day)	4.9 hours (59 mins/day)

Relationship of State Policies to Course Enrollments

In the 1980s, over 40 states increased science and mathematics course credit requirements for graduation. As of 1989, 34 states require two credits of mathematics and 13 require either three mathematics credits or five credits in mathematics or science (average 2.5 credits). Thirty-eight states require two credits of science, and six require either three credits or five credits in mathematics or science (average 2.5 credits). The number of credits required in each state is provided in Appendix Table A-1. The state-by-state and national analyses of science and mathematics course enrollments show that course taking has increased since 1982, and the results imply that increased course taking is related to policy reforms raising graduation requirements. But do the states that have higher requirements have higher rates of course taking in science and mathematics? The state indicators can help in addressing this question.

Clune's (1989) analysis of course taking in six states showed that the highest increases in course taking were in basic, lower level courses. One interpretation of this finding is that higher state requirements have the effect of expanding the number of lower level courses. The Reform Up Close study currently being conducted by the Center for Policy Research in Education, with support from NSF, is examining curriculum than is provided in courses previously offered in science and mathematics. Another interpretation of increased levels of course taking is that regardless of the level of course difficulty students are likely to learn more science and mathematics by taking more courses, even if the courses are less rigorous (NASSP, 1989; Raizen and Jones, 1985).

The CCSSO science and mathematics indicators were planned to provide analyses of course taking in relation to state policies. To conduct the analyses, state policies were divided into three categories: (a) states requiring two and a half to three Carnegie course credits, (b) states requiring two credits, and (c) states requiring one credit or no state, only local, requirements.

State Policies by Mathematics Course Enrollments. To analyze state policies and course taking, high school mathematics courses were divided into three categories that represent significant steps in advancement through the mathematics curriculum: (a) review and informal mathematics, (b) formal mathematics level 1 (algebra 1), (c) formal mathematics levels 2–5 (geometry through calculus). Course taking data were aggregated according to these categories. (State-by-state enrollments by these categories are shown in Appendix Table A-2.)

High School Mathematics Enrollments By Course Category

Review and informal mathematics (general, pre-algebra)	27%
Formal mathematics 1 (algebra 1)	21
Formal mathematics 2–5/upper level (geometry through calculus)	34
Total mathematics enrollment (including 2% other)	84%

Table 7 shows the results of cross-tabulating state policies and state mathematics enrollments. The first column shows the *total percent of students in grades 9–12 taking mathematics.* Among the 11 states requiring two and a half to three credits, the median state percentage is 91 percent. The median among 20 states requiring two credits is 81 percent, and the median among four states with local control is 74 percent. The differences between state groups show that states which require students to have more credits for graduation have more students taking mathematics courses.

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[5] The standard errors for mathematics and science hours per week are less than 0.1 hour for all states.

Table 6
ELEMENTARY CLASS TIME ON MATHEMATICS AND SCIENCE
(Public Schools)

STATE	MATHEMATICS Grade 1-3 Hours/Week	MATHEMATICS Grade 4-6 Hours/Week	SCIENCE Grade 1-3 Hours/Week	SCIENCE Grade 4-6 Hours/Week
ALABAMA	4.8	4.8	2.8	3.7
ALASKA	4.7	4.7	2.3	3.0
ARIZONA	5.0	5.3	2.2	3.2
ARKANSAS	5.0	5.0	2.4	3.4
CALIFORNIA	4.9	4.7	2.5	2.7
COLORADO	5.0	4.9	2.6	3.2
CONNECTICUT	5.0	5.3	2.0	3.0
DELAWARE	4.7	4.4	1.8	2.3
DIST OF COLUMBIA	6.0	4.8	2.9	3.0
FLORIDA	4.9	4.9	2.6	3.2
GEORGIA	4.6	4.9	2.6	3.3
HAWAII	4.5	5.5	2.3	2.8
IDAHO	4.7	4.9	2.5	2.9
ILLINOIS	4.6	4.8	2.2	3.3
INDIANA	5.7	4.5	2.9	3.2
IOWA	4.3	5.0	2.2	2.7
KANSAS	4.8	4.9	2.2	3.1
KENTUCKY	5.0	4.7	2.9	3.5
LOUISIANA	4.6	5.4	3.3	3.6
MAINE	4.7	4.7	2.7	3.0
MARYLAND	5.3	5.0	2.0	2.9
MASSACHUSETTS	5.2	5.4	1.8	2.3
MICHIGAN	4.9	5.0	2.7	2.8
MINNESOTA	4.4	4.7	2.4	2.3
MISSISSIPPI	5.2	6.0	2.8	2.4
MISSOURI	5.2	4.9	2.3	3.6
MONTANA	4.6	3.8	2.1	3.3
NEBRASKA	4.3	4.9	2.2	3.5
NEVADA	4.9	4.8	1.9	3.2
NEW HAMPSHIRE	4.6	5.0	2.0	4.1
NEW JERSEY	4.6	5.2	2.1	2.4
NEW MEXICO	5.3	5.4	2.6	3.5
NEW YORK	5.0	4.8	2.2	3.0
NORTH CAROLINA	4.8	5.3	2.9	3.8
NORTH DAKOTA	4.7	4.7	2.3	3.4
OHIO	4.2	4.1	2.1	3.3
OKLAHOMA	4.6	4.3	2.3	3.1
OREGON	5.0	4.7	2.2	3.0
PENNSYLVANIA	4.7	4.7	2.1	2.7
RHODE ISLAND	4.8	4.8	1.3	2.4
SOUTH CAROLINA	5.0	5.1	2.4	3.4
SOUTH DAKOTA	5.0	5.1	2.7	3.5
TENNESSEE	4.9	5.5	2.4	2.8
TEXAS	5.1	5.1	3.5	4.0
UTAH	4.9	5.0	2.1	2.2
VERMONT	5.2	4.8	2.8	2.9
VIRGINIA	5.2	5.2	2.4	3.0
WASHINGTON	4.7	4.5	1.9	2.6
WEST VIRGINIA	4.7	4.6	1.9	3.0
WISCONSIN	4.5	5.4	2.4	2.9
WYOMING	4.5	4.6	2.7	3.7
MEDIAN	4.8	4.9	2.3	3.0

Source: Schools and Staffing Survey, National Center for Education Statistics, Spring 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Table 7

STATE GRADUATION REQUIREMENTS BY PERCENT OF STUDENTS IN GRADES 9–12 TAKING MATHEMATICS COURSES

(October 1989, Public Schools)

Mathematics Carnegie Credits Required by State	Total Percent Taking Mathematics	Percent Taking Upper Level Mathematics	Percent Taking Review & Informal Mathematics
2.5 to 3 CREDITS			
ARKANSAS	90%	31%	37%
CONNECTICUT	88	38	34
FLORIDA	93	29	46
KENTUCKY	88	35	34
LOUISIANA	85	43	13
MARYLAND	96	42	33
NEW MEXICO	96	30	38
PENNSYLVANIA	83	46	14
SOUTH CAROLINA	97	34	45
TEXAS	91	35	32
VIRGINIA	91	40	29
MEDIAN	91%	35%	34%
2 CREDITS			
ALABAMA	73%	28%	28%
CALIFORNIA	79	29	22
DELAWARE	86	33	38
DISTRICT OF COLUMBIA	75	30	28
HAWAII	87	21	53
IDAHO	81	38	16
ILLINOIS	70	33	16
INDIANA	80	33	31
KANSAS	80	32	28
MISSISSIPPI	83	38	24
MISSOURI	81	36	19
MONTANA	88	41	23
NEVADA	90	30	26
NEW YORK	73	26	30
NORTH CAROLINA	88	37	32
NORTH DAKOTA	84	44	15
OHIO	85	36	28
OKLAHOMA	78	34	19
TENNESSEE	74	28	24
WISCONSIN	84	29	34
MEDIAN	81%	33%	26%
NO STATE REQUIREMENTS			
IOWA	86%	43%	20%
MINNESOTA	74	41	12
NEBRASKA	78	36	17
WYOMING	73	25	33
MEDIAN	74%	36%	17%
TOTAL (35 states)	84%	34%	27%

Percent Taking Upper Level Mathematics=Percent of students taking a course in one of the following: Formal Math Levels 2-5 (e.g. geometry, algebra 2, trigonometry, calculus); Review & Informal=Percent of students taking a course in general math, applied math, or pre-algebra.

Total=Sum of students taking the course in reporting states.

Sources: CCSSO; State Depts. of Education, Data on Public Schools, Fall 1989; N. Carolina and Wisconsin, Fall 1988

Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

The second column shows the *percent taking upper level mathematics* (including geometry, algebra 2, trigonometry, calculus). The median of 35 percent for states requiring two and a half to three credits is slightly higher than the median for states requiring two credits (33%). The percent of students taking upper level mathematics in states requiring more mathematics credits varies from 29 percent (Florida) to 46 percent (Pennsylvania), while the variation among states requiring two credits is from 21 percent (Hawaii) to 44 percent (North Dakota). Four of the 11 states requiring more than two courses have more than 40 percent of students taking upper level mathematics (Pennsylvania, Louisiana, Maryland, Virginia), while only two of 20 states requiring two credits have more than 40 percent taking upper level mathematics (North Dakota, Montana). It should be noted that two of the four states with local control (Iowa, Minnesota) also have over 40 percent taking higher level mathematics. These states did not create state requirements when other states were raising state standards in the 1980s. Possibly, state policy-makers viewed their rates of course taking in mathematics and science to already be high. Figure 4 provides a histogram showing the rank order of state percentages of students taking upper level mathematics.

The third column in Table 7 shows state differences in *percent taking review and informal math,* i.e., lower level mathematics courses. It should be noted that a total of 27 percent, or over one-fourth of all high school students, were taking a review or informal mathematics course, i.e., a course with curriculum content at the middle school or junior high level. (The total for review mathematics is 19 percent, the total for informal mathematics is 8 percent, see Appendix Table A-4.)

Among the 11 states that require more than two mathematics credits for graduation, the median is 34 percent of students taking lower level mathematics. Among states requiring two credits in mathematics, the median is 26 percent. The 10 percent median difference in total mathematics enrollments between states requiring more than two credits and those requiring two credits can largely be attributed to the eight percent average difference in course taking in lower level mathematics.

State Policies and Science Course Enrollments. Science course enrollments in grades 9–12 were aggregated in three categories that represent significant steps in advancement through the science curriculum: (a) introductory science (earth, physical, general), (b) first year biology, (c) upper level science (chemistry, physics, advanced courses). Course taking data were aggregated according to these categories. (State-by-state enrollments by these categories are shown in Appendix Table A-3).

High School Science Enrollments by Course Category

Introductory (earth, physical, general)	23%
First year biology	26
Upper level science (chemistry, physics, advanced)	21
Total science enrollments (includes 2% other)	72%

The results of cross-tabulating state requirements for science credits and course enrollments are shown in Table 8. The first column shows the *total percent of students in grades 9–12 taking science.* Among five states requiring two and a half to three science Carnegie credits, the state median is 80 percent. Among the 23 states requiring two science credits the median is 71 percent. The median is also 71 percent among the six states with one credit required or no state requirement. These results confirm previous studies showing overall higher enrollment figures in science with higher requirements.

The second column shows the *percent taking upper level science.* Figure 5 gives a graphic display of variation in the state percentages of students taking upper level science courses. Among the five states requiring two and a half to three credits, the median state had 25 percent of students taking upper level science. Among states requiring two credits, the median is 21 percent enrolled, and states with one credit or no state requirement enroll a median of 20 percent. Among high requirement states, the percent taking upper level science varies from 11 percent (Arkansas) to 28 percent (Florida), while among states requiring two credits the percent varies from 13 percent (Oklahoma) to 35 percent (Mississippi). There is some evidence that higher science requirements are related to more upper level course taking, although the data are not conclusive because of the small number of states with higher science requirements.

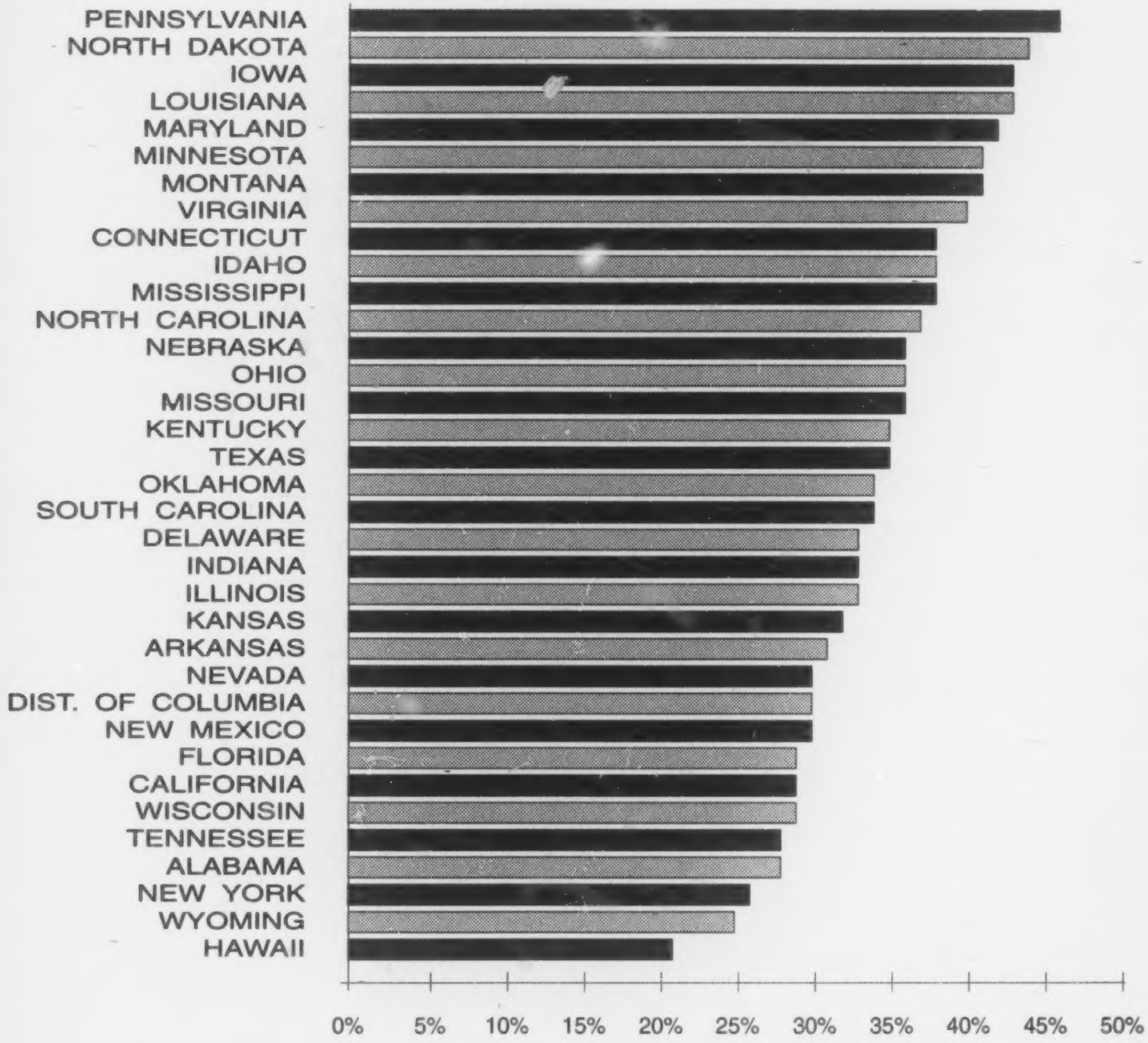
Seven states that reported course taking data award honors or advanced diplomas that require a higher number of science credits: Alabama, Florida, Indiana, Kentucky, Maryland, Missouri, and Texas (see Appendix Table A-1). There is no pattern of higher levels of course taking among these states, and data were not reported on the number of students that have earned these diplomas.

The third column gives the *percent taking introductory science.* Almost one-fourth (23%) of high school students were taking courses in earth science, physical science, or general science, and enrollments in these comprised one-third of all science course taking. The five states that require two and a half to three science credits have a median of 29 percent of students enrolled in introductory courses. Among the states requiring two credits, the median is 25 percent of students, and states with one credit or no requirement have a median of 22 percent. Thus, the nine percent median difference in total science enrollments between states requiring more than two credits and those requiring two credits can be equally attributed to the difference in course taking in lower level (introductory) science courses (4%) and the difference in upper level course taking (4%).

Further analyses of course taking in lower level science courses are possible with the state science and mathematics indicators. The CCSSO course taxonomy and reporting definitions include separate categories for basic or applied and

Figure 4

Percent of Public School Students in Grades 9-12 Taking Upper Level Mathematics Courses in October 1989



Percent of students in grades 9-12 taking upper level mathematics
Total (35 States) = 34%

Upper level mathematics includes courses in geometery, algebra 2 trigonometry, and calculus

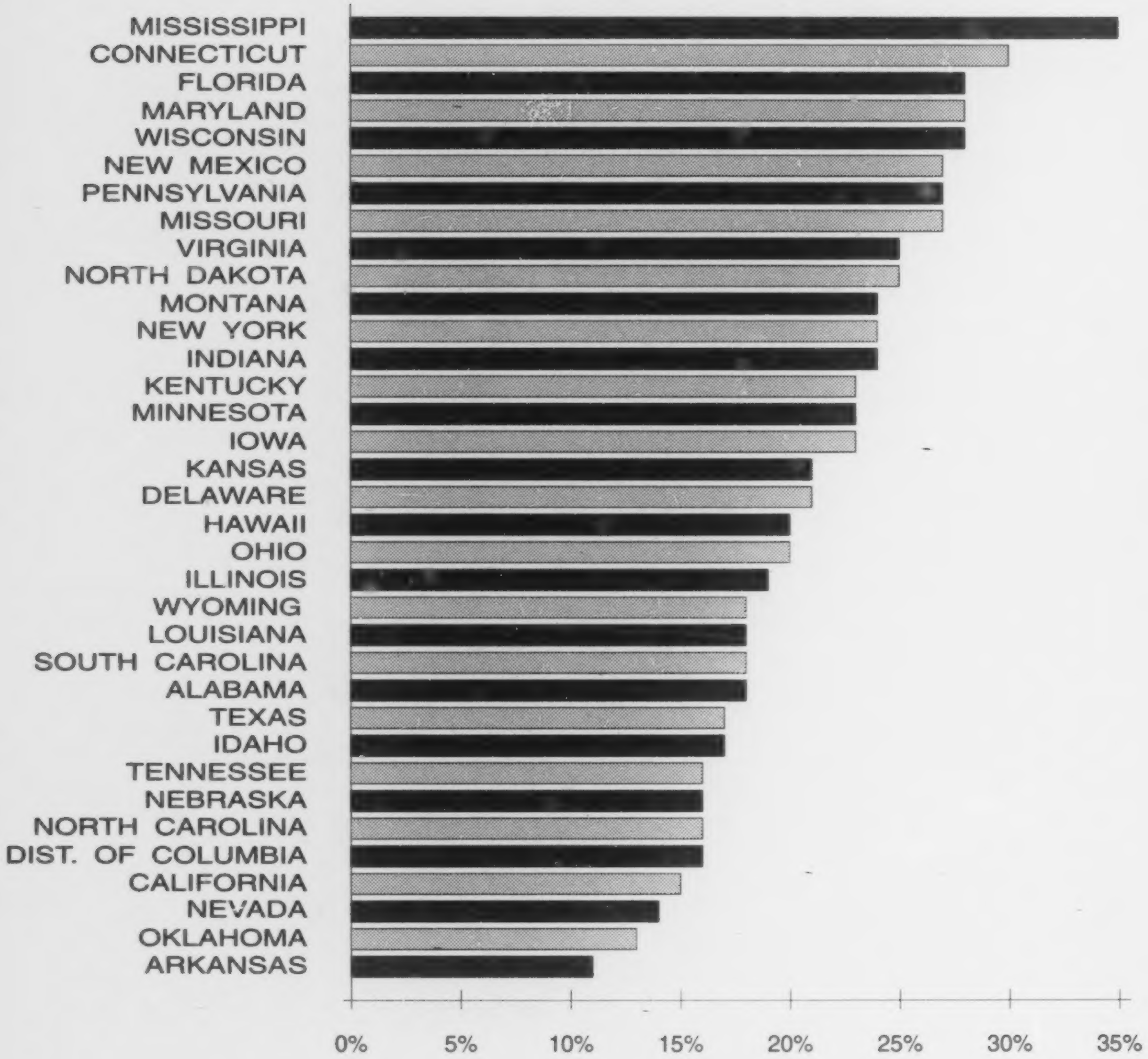
Source: State Departments of Education, Data on Public Schools, Fall 1989
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Table 8
STATE GRADUATION REQUIREMENTS BY PERCENT OF STUDENTS IN GRADES 9–12 TAKING SCIENCE COURSES
(October 1989, Public Schools)

Science Carnegie Credits Required by State	Total Percent Taking Science	Percent Taking Upper Level Science	Percent Taking Introductory Science
2.5 TO 3 CREDITS			
ARKANSAS	76%	11%	37%
FLORIDA	87	28	30
LOUISIANA	80	18	29
PENNSYLVANIA	85	27	21
VIRGINIA	76	25	25
MEDIAN	80%	25%	29%
2 CREDITS			
ALABAMA	69%	18%	23%
CALIFORNIA	63	15	18
CONNECTICUT	81	30	22
DELAWARE	78	21	30
DISTRICT OF COLUMBIA	63	16	25
HAWAII	71	20	25
IDAHO	60	17	18
INDIANA	71	24	22
KANSAS	78	21	25
KENTUCKY	73	23	25
MARYLAND	78	28	19
MISSISSIPPI	76	35	10
MISSOURI	78	27	28
NEVADA	49	14	13
NEW MEXICO	67	27	25
NEW YORK	83	24	26
NORTH CAROLINA	71	16	27
NORTH DAKOTA	82	25	28
OKLAHOMA	65	13	23
SOUTH CAROLINA	72	18	28
TENNESSEE	69	16	29
TEXAS	[illegible]	17	24
WISCONSIN	[illegible]	28	24
MEDIAN	71%	21%	25%
1 CREDIT OR NO STATE REQUIREMENT			
ILLINOIS	56%	19%	15%
IOWA	71	23	20
MINNESOTA	74	23	22
MONTANA	72	24	22
NEBRASKA	70	16	23
OHIO	72	20	25
WYOMING	69	18	23
MEDIAN	71%	20%	22%
TOTAL (35 states)	72%	21%	23%

Percent Taking Upper Level Science= Percent of students taking a course in one of the following: First year chemistry or physics, advanced/second year biology, chemistry, physics, or earth science; Introductory Science = Percent of students taking first year earth, physical, or general sciences.
Total = Sum of students taking the course in reporting states.
Sources: CCSSO; State Depts. of Education, Data on Public Schools, Fall 1989; N. Carolina and Wisconsin, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Figure 5
Percent of Public School Students in Grades 9-12 Taking Upper Level Science Courses in October 1989



Percent of students in grades 9-12 taking upper level science
Total (35 States) = 21%

Upper level science includes courses in first year chemistry, physics and second year/advanced biology, chemistry, physics, and earth science

Source: State Departments of Education, Data on Public Schools, Fall 1989
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Table 9
ENROLLMENTS IN PUBLIC HIGH SCHOOL MATTHEMATICS AT FOUR LEVELS BY STUDENT GENDER (October 1989)

	FORMAL MATH Level 1 (Algebra 1)			FORMAL MATH Level 3 (Algebra 2)			FORMAL MATH Level 4 (Trigonometry)			FORMAL MATH Level 5 (Calculus)		
STATE	Total Level 1	% Boys	% Girls	Total Level 3	% Boys	% Girls	Total Level 4	% Boys	% Girls	Total Level 5	% Boys	% Girls
ARKANSAS	26,997	49%	51%	14,458	46%	54%	6,166	51%	49%	1,306	54%	46%
CALIFORNIA	276,017	50	50	133,024	49	51	59,124	51	49	22,720	56	44
CONNECTICUT	19,068	49	51	17,689	49	51	10,629	52	48	3,957	51	49
DIST OF COLUMBIA	3,248	49	51	1,862	41	59	805	38	62	136	46	54
HAWAII	5,188	45	55	3,423	45	55	1,773	48	52	378	55	45
IDAHO	13,095	47	53	8,868	53	47	1,924	52	48	785	63	37
ILLINOIS	90,426	50	50	45,133	50	50	32,603	52	48	9,945	57	43
IOWA	31,409	50	50	20,354	48	52	10,181	53	47	3,180	57	43
KANSAS	19,559	50	50	13,095	48	52	6,513	53	47	2,403	54	46
MARYLAND	34,908	50	50	22,843	45	55	18,806	48	52	5,532	53	47
NEVADA	10,648	50	50	3,866	48	52	1,883	56	44	524	65	35
PENNSYLVANIA	111,102	50	50	67,244	49	51	63,464	50	50	18,463	54	46
SOUTH CAROLINA	27,508	49	51	22,132	47	53	10,163	48	52	2,430	53	47
WEST VIRGINIA	16,130	48	52	9,894	45	55	4,960	50	50	905	55	45
WISCONSIN	46,662	50	50	20,338	49	51	14,154	54	46	5,232	55	45
WYOMING	26,917	53	47	1,918	48	52	1,631	53	47	338	61	39
MEDIAN		50%	50%		48%	52%		52%	48%		55%	45%

Source: State Departments of Education, Data on Public Schools, Fall 1989; Wisconsin, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

general first year courses in biology, chemistry, and physics.[6] This distinction, which is included in many of the state data codes, allows tracking of the level of courses students take within these three fields. The data reported in Appendix Table A-9 show that enrollments in basic biology are a substantial portion of course taking in first year biology in some states (Hawaii, 43%, Connecticut and Delaware, 41%, California, 32%), and the median is 18 percent of course enrollments in first year biology. The median state percent of first year chemistry enrollments in basic or applied chemistry courses is six percent, and the median for first year physics is three percent.

Science and Mathematics Course Enrollments by Student Gender

The national averages on high school course taking in science and mathematics in the 1987 transcript study (Kolstad and Thorne, 1989) showed that differences in course taking between boys and girls decreased from 1982 to 1987. Sixteen states reported course enrollment data by gender, and the data show that differences still exist at the upper level science and mathematics courses. Table 9 shows results for *mathematics.* In each state, the enrollment rate of boys and girls is the same at formal mathematics level 1 (algebra 1). There are slightly more girls taking algebra 2 in 14 of the 16 states. At levels 4 and 5 (trigonometry and calculus) the pattern among states is higher rates among boys. From 3 to 13 percent more boys than girls are enrolled in calculus in 15 states, with D.C. being the exception to the pattern. The findings show that the gender gap exists at the most advanced mathematics classes as of Fall 1989.

In *science,* Table 10 shows that across the 16 states, course taking in first year biology is the same for boys and girls. From 1 to 7 percent more girls took first year chemistry in 13 states. First year physics has more boys enrolled in all 16 states, with differences varying from three to 13 percent. The advanced courses show a mixed pattern, with more girls enrolled in advanced biology in all states, and more boys enrolled in advanced physics in all states. Eleven states had more boys enrolled in advanced chemistry, and three had more girls enrolled.

Results from the 1986 National Assessment of Educational Progress (NAEP) showed that boys have higher scores than girls on the earth science, chemistry, and physics portions of the test, but scores for boys and girls are approximately equal on the biology portion (Mullis, et al., 1988). On the NAEP in mathematics, boys consistently perform better on more complex mathematical procedures than girls (Dossey, et al., 1988). Given these findings from student achievement tests, it is important to continue to track course enrollments for girls and boys in mathematics and science courses as a possible source of differences in student learning. The 1989–90 state indicators show that gender differences in course taking appear to be diminishing at the end of the 1980s. The availability of trend data at the state level through the state science and mathematics indicators

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[6] A "general" first year course in biology, chemistry, and physics is the traditional first year course in these fields, typically a broad survey course that introduces the field to students but also is aimed at students planning to pursue further study in science. An "applied" or "basic" course emphasizes central principles, concepts, and applications, and typically is aimed at students who are not planning further study in science.

Table 10
ENROLLMENTS IN PUBLIC HIGH SCHOOL BIOLOGY, CHEMISTRY, AND PHYSICS BY STUDENT GENDER (October 1989)

State	BIOLOGY						CHEMISTRY						PHYSICS					
	First Year			2nd Year (AP/Other Advanced)			First Year			2nd Year (AP/Other Advanced)			First Year			2nd Year (AP/Other Advanced)		
	Total	% Boys	% Girls	Total	% Boys	% Girls	Total	% Boys	% Girls	Total	% Boys	% Girls	Total	% Boys	% Girls	Total	% Boys	% Girls
ARKANSAS	34,248	50%	50%	—	—	—	9,925	48%	52%	—	—	—	3,680	57%	43%	—	—	—
CALIFORNIA	308,629	51	49	34,106	44%	56%	100,365	50	51	7,377	57%	43%	42,057	58	42	3,750	61%	39%
CONNECTICUT	30,984	48	52	4,611	41	59	17,893	51	49	805	56	44	10,494	64	36	597	70	30
DIST OF COL.	4,086	47	53	160	40	60	2,132	43	57	124	41	59	518	37	63	29	59	41
HAWAII	9,570	50	50	534	34	66	4,160	45	55	146	58	42	2,097	52	48	69	67	33
IDAHO	11,955	50	50	2,320	47	53	3,494	49	51	63	27	73	2,005	69	31	309	76	24
ILLINOIS	97,849	49	51	15,766	45	55	45,926	49	51	4,106	58	42	21,848	60	40	996	71	29
IOWA	37,035	50	50	2,868	38	62	18,329	49	51	—	—	—	9,022	60	40	—	—	—
KANSAS	32,127	50	50	5,461	47	53	12,424	51	49	867	60	40	4,676	63	37	173	73	27
MARYLAND	49,556	49	51	8,817	45	55	26,565	47	53	1,877	49	51	11,843	53	47	1,018	69	31
NEVADA	8,291	50	50	963	46	54	3,998	49	51	370	56	44	1,453	60	40	23	100	0
PENNSYLVANIA	141,829	51	49	17,063	45	55	65,610	48	52	7,617	53	47	33,494	55	45	2,828	67	33
SO. CAROLINA	43,147	50	50	4,192	44	56	20,132	47	53	1,324	55	45	5,849	62	38	153	76	24
WEST VIRGINIA	24,497	51	49	7,058	44	56	9,401	46	54	1,124	54	46	2,527	58	42	25	64	36
WISCONSIN	56,566	51	49	12,524	47	53	28,673	48	52	5,294	54	46	13,828	60	40	2,636	58	42
WYOMING	5,890	52	49	1,296	46	54	2,379	52	48	205	54	46	873	64	36	30	79	21
MEDIAN		50%	50%		45%	55%		49%	51%		55%	45%		60%	40%		70%	30%

Source: State Departments of Education, Data on Public Schools, Fall 1989; Wisconsin, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

will be important for analyzing gender differences particularly to determine if some states are able to continue to close the gender gap.

INDICATORS OF TEACHER SUPPLY, DEMAND, AND QUALITY

The CCSSO Project placed a high priority on state indicators of teacher supply, demand, and quality in science and mathematics. There is evidence of the need for better indicators. In the early 1980s severe shortages of qualified science and mathematics teachers were predicted. Current data show that there are shortages in specific science fields in many states and districts and general shortages of qualified science and mathematics teachers in a few states and in many urban and rural school districts. This report provides data on several indicators of the supply and demand for teachers and qualifications of current science and mathematics teachers. Policymakers and educators have a need for additional indicators focusing on the quality of initial teacher education and the quality of continuing professional development of teachers.

Issues in Teacher Quality and Shortages. One of the central objectives of national and state education policy reforms in the 1980s was improving the quality of teachers. National commission reports of the 1980s (National Science Board, 1983; Carnegie Forum on Education and the Economy, 1986) highlighted the problems of underqualified teachers in science and mathematics classrooms and impending teacher shortages, particularly if greater emphasis is placed on instruction in these subjects. In 1984, the National Science Teachers Association (NSTA) estimated that 30 percent of all secondary science and mathematics teachers were "completely unqualified or severely underqualified" (based on NSTA standards) to teach these subjects (Johnston and Aldridge). In the early 1980s, science and mathematics teachers were leaving teaching at a much higher rate than the number of new college graduates entering teaching (Aldrich, 1983). Darling-Hammond's (1984) review of national data identified four reasons for concern about the quality of science and mathematics teachers: (a) the number of teachers teaching out-of-field, (b) the low number of new entering science and mathematics teachers, (c) the high numbers of science and mathematics teachers reaching retirement age, and (d) a high proportion of science and mathematics teachers leaving teaching before retirement age.

State and National Policies. Policy initiatives at state and national levels helped to address shortages and teacher preparation. Federal funding created new programs for improving the knowledge and skills of teachers in science and mathematics after 1983. The Education for Economic Security Act of 1984 (now the Dwight D. Eisenhower Program to Improve Science and Mathematics Education) provided funds to higher education institutions, states, and local school districts to upgrade the knowledge and skills of science and mathematics teachers. The National Science Foundation has expanded programs to enhance teachers' knowledge and skills in their teaching fields.

Many states devised policies to increase the supply of teachers in science and mathematics. States are interested in better indicators in order to assess these policies. States increased the pay scale of teachers to retain and attract teachers and provided loans for students entering training in shortage fields. States also raised requirements for teacher certification in science and mathematics at elementary and secondary levels (Education Commission of the States, 1987; Blank and Espenshade, 1988b). Some states passed alternative certification policies intended to attract non-certified college graduates into teaching (CCSSO, 1989a). Many states instituted mandatory teacher assessments to ensure that new teachers (and, in two states all teachers) had a minimum level of verbal ability, knowledge of their teaching field, and knowledge of education in general (CCSSO, 1989a).

At the national level, teacher shortages are currently not as high as predicted in the early 1980s for several reasons. A significant portion of recent new hires are from the reserve pool of teachers who left teaching and are now returning (NRC, 1990). In addition, the attrition rate of teachers has not increased since 1982. The rate was four percent for public school teachers as of the 1987–88 Schools and Staffing Survey (Rollefson, 1990). Finally, the number of new college graduates in science and mathematics education increased in the 1980s (Lauritzen, 1990).

Improving Indicators of Teachers. There is a need for better national and state statistics on the supply, demand, and quality of science and mathematics teachers in order to identify problem areas and to better assess the quality of current teachers (NRC, 1987, 1990). Better data are needed on shortages in specific teaching fields. Weiss conducted a follow-up survey with secondary science and mathematics teachers originally surveyed in 1985–86 and found that about 85 percent were still in teaching in 1988, which is an annual attrition rate of 5 percent (1989). However, teacher shortages are a problem in specific fields such as the physical sciences. physics and chemistry teachers are harder to hire than teachers in any other field (Weiss, 1987), and attrition rates are higher for teachers in these fields (Murnane, et al., 1988).

The national educational goal for improving science and mathematics learning has a key objective of increasing the number of well qualified teachers (National Governors Association, 1990), and data are needed to track progress on this objective. Regularly reported statistics on the quality of preparation of science and mathematics teachers are also needed at national and state levels (National Research Council, 1990). Analyses of the preparation of a national sample of teachers in 1985–86 showed that many teachers did not meet the standards of the science and mathematics education associations (Weiss, 1989; National Science Board, 1989). In addition, unequal distribution of the available qualified teachers by socio-economic characteristics of students and schools produces differential access to opportunities for study in science and mathematics (Oakes, 1990a).

The CCSSO Science and Mathematics Indicators Project gave high priority to developing three types of indicators of teacher quality: (a) teacher supply and demand, (b) equity in the teaching force, and (c) teacher preparation. Another priority area for state indicators of science and mathematics is school conditions which affect teaching and learning.

The CCSSO plan for state-by-state indicators of science and mathematics is based on cross-sectional data which can be compared by state and tracked over time. Some desirable indicators of teacher quality that require more complex data or qualitative measurement are not reported, indicators such as teacher knowledge and skills and teaching practices in the classroom. CCSSO would prefer to analyze teacher quality state-by-state with these measures if the data were available. Possible indicators for which data are available, such as degree level and years of experience, were not included because they do not significantly add to the analysis of teacher quality in science and mathematics.

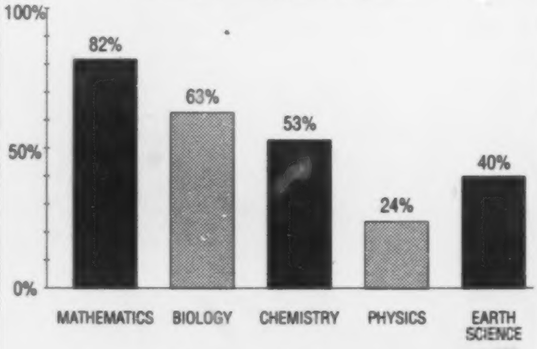
To obtain comparable state data on the priority indicators of teachers, two sources of data were used. States reported data on teachers through the CCSSO reporting system designed by the Science and Mathematics Indicators Project. Second, CCSSO conducted state-by-state analyses of the Schools and Staffing Survey of NCES.

Indicators of Current Teacher Supply

States reported data on the total number of teachers assigned to teach science, mathematics, and computer science in grades 9–12 as of October 1, 1989. The state teacher numbers are universe counts based on data collected through state information systems. The CCSSO state data reporting plan requested the number of teachers with primary and secondary assignments in each of eight subjects. The operational definition of primary assignment is a teacher assigned to one subject for 50% or more of teaching periods; and secondary assignment is a teacher assigned to one subject less than 50% of teaching periods.

Primary vs. secondary assignments of teachers. Figure 6 shows the median state percentage of teachers in each of five

Figure 6
Primary Assignment of Teachers
of Mathematics and Science



Percent of teachers in each subject that have their primary assignment in the subject (Median State Percentage)

subjects that have their primary assignment in these subjects. The state data show that mathematics has the highest proportion of teachers with their primary assignment in mathematics. Almost half of chemistry teachers have their primary assignment in another subject, and three-fourths of physics teachers have their primary assignment in another subject. For example, in many schools, physics is taught by a teacher with primary assignment in chemistry or earth science.

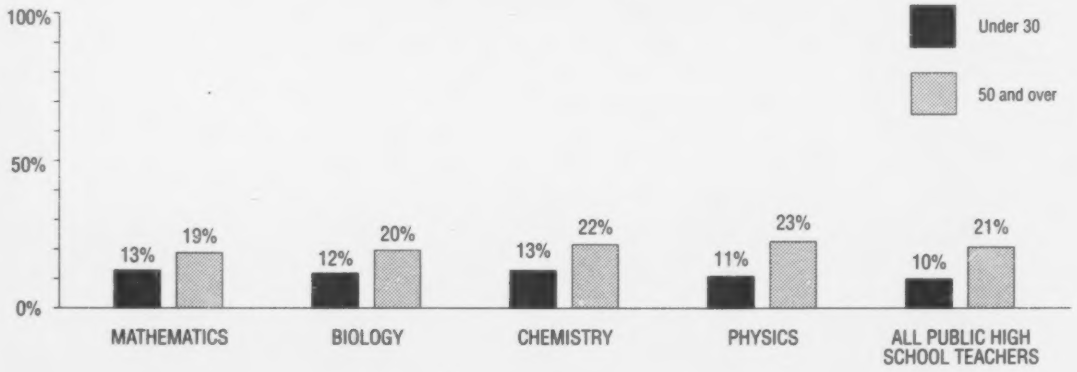
Appendix Tables B-1 to B-4 provide state-by-state data on assignments for mathematics, six science fields, and computer science. Tables B-1, B-2, and B-3 also show the total number of high school teachers in five subjects. In the U.S., as of 1989–90 there were 111,000 mathematics teachers, 46,000 biology teachers, 21,000 chemistry teachers, 13,700 physics teachers, and 13,300 earth science teachers. Table B-5 reports state-by-state figures for the total number of high school science teachers in all fields (i.e., teacher headcounts) based on a state representative sample of teachers in the 1988 Schools and Staffing Survey. The 50 state total is 102,000 science teachers.

States vary in the proportion of teachers with primary assignments in science and mathematics. For example, teachers of mathematics in Connecticut (95% primary assignment) and Illinois (96%) are almost all teaching mathematics as their primary assignment, while California (68%) and Utah (69%) have about one-third of teachers of mathematics who have their primary assignment in another subject.[7] Higher numbers of teachers with secondary assignments are probably due to population growth (such as in California) as well as increases in state course requirements. States with more small, rural districts, such as Arkansas, Oklahoma, and North Dakota have fewer teachers with primary assignments in any of the science fields, and states with a greater proportion of urban and suburban districts, such as Connecticut, New York, and Pennsylvania, have more teachers with primary assignments in the science fields.

Age of science and mathematics teachers. Although the state science and mathematics indicators do not include detailed projections of teacher supply and demand, the age distributions of current science and mathematics teachers provide useful information on possible shortage fields as teachers near retirement age. Figure 7 shows summary statistics from the state aggregate data on teacher assignments by teacher age. Illustrated are the proportion of teachers aged 50 and over and under age 30 in the 36 reporting states. (The proportion of teachers aged 30–49 is not shown; it is the difference from 100%). The proportion of teachers over age 50 varies from 19 percent of mathematics teachers to 23 percent of physics teachers. The proportion under 30 varies from 13 percent in mathematics and chemistry to 12 percent in biology and 11 percent in physics.

The age distributions of mathematics and science teachers vary widely by state in all fields. Figure 8 illustrates the state differences for mathematics teachers. (Appendix Table B-6 gives complete state data.) The percentage of mathematics teachers over age 50 varies from 29 percent in Minnesota to 10 percent in Kentucky, as compared to 10 percent under 30 in Minnesota and 19 percent under 30 in Kentucky. In chemistry, the percentage over 50 varies from 45 percent in Minnesota to 10 percent in Nevada, as compared to nine

Figure 7
Percentage of Mathematics and Science Teachers Under Age 30 and Over Age 50 (36 States)



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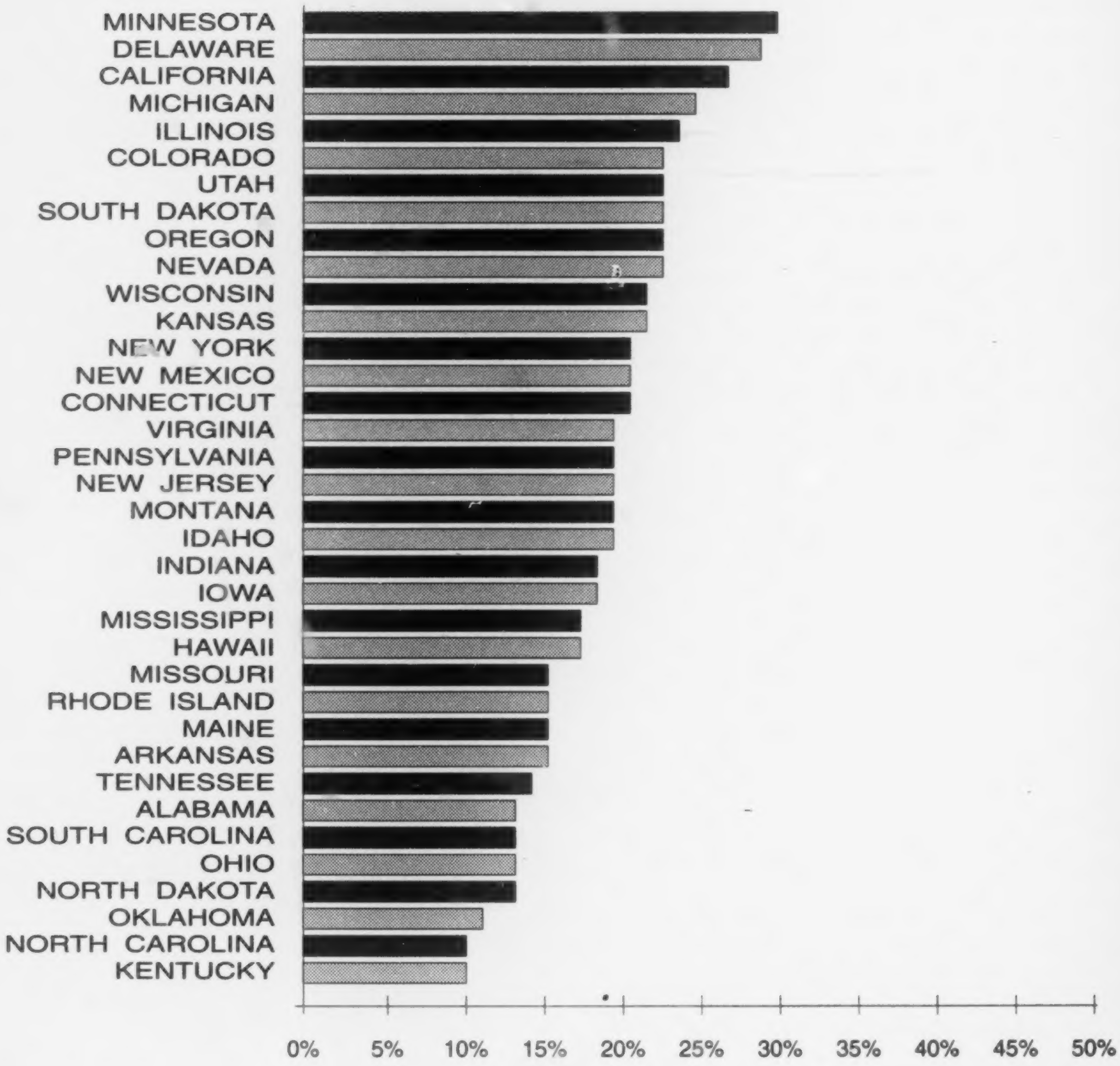
[7] Several states reported teacher assignments by student enrollments. For example, in California 87 percent of students taking mathematics were taught by a primary assignment mathematics teacher and 72 percent of students taking chemistry were taught by a primary assignment chemistry teacher. In South Carolina, 95 percent of students taking mathematics were taught by a primary assignment mathematics teacher and 81 percent of students taking chemistry were taught by a primary assignment chemistry teacher.

Figure 8
Percent of Mathematics Teachers Age 50 and Over



Percent of mathematics teachers age 50 and over
Total (36 States) = 19%

Source: State Departments of Education, Data on Public Schools, Fall 1989
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

percent under 30 in Minnesota and 13 percent under 30 in Nevada.

The age distribution for mathematics and science teachers can be compared with the age statistics for all high school teachers. A total of 21 percent of all high school teachers are over 50, and 10 percent are under 30 (see Appendix Table B-10 for state data). Only the fields of chemistry and physics have higher percentages of teachers over 50 than the average for high school teachers. There are slightly higher percentages of teachers under 30 in mathematics and science than the average for high school teachers.

One way of analyzing the teacher age statistics by state is to note that states which have had flat or declining populations, particularly northeastern and midwestern states, have higher proportions of older science and mathematics teachers (e.g., Connecticut, Delaware, Illinois, Iowa, Minnesota, New York, Rhode Island, and Wisconsin). Many of the teachers over 50 in these states were hired in the 1960s when school enrollments were increasing. These states may experience a shortage of teachers in a few years as this group of teachers reaches retirement age.

Indicators of Equity in the Teaching Force

States reported data on two indicators of equity among current teachers in science and mathematics: gender and race/ethnicity. The distribution of science and mathematics teachers by gender and race/ethnicity provides a basis for states and the nation to compare the characteristics of the current teaching force with goals of improving the match between students and teachers in terms of gender and race/ethnic characteristics.

Weiss' (1987) analysis of national data on teacher characteristics showed that minority science and mathematics teachers and female science teachers are vastly under represented considering the student population in our schools, and state level data are needed on teachers in these groups. An indicator of equity of teacher quality addresses the issue of distribution of opportunities in science and mathematics education. There are two related aspects of the issue. Oakes' (1990a) analysis of science and mathematics teachers by school characteristics shows that students in schools with students from predominantly low socioeconomic status backgrounds have fewer opportunities to be taught by highly qualified teachers. Second, the rate of participation of minority and female students in science and mathematics is related to the characteristics of their teachers (Oakes, 1990b).

Gender of Science and Mathematics Teachers. In 1985–86, approximately 48 percent of high school mathematics teachers were female and 36 percent of science teachers were female (Weiss, 1989). Figure 9 provides summary statistics on the gender of science and mathematics teachers in four fields as of 1989–90 based on state data.

The percentage of female teachers differs by subject: 45 percent in mathematics, 37 percent in biology, 34 percent in chemistry, and 22 percent in physics. By comparison, 50 percent of all high school teachers are female, and 50 percent are male (based on the sum of state data, see Appendix Table B-10).

State-by-state statistics on the gender of mathematics and science teachers show that the distributions vary widely (see Appendix Table B-7). In mathematics, the percent of female teachers varies from 21 percent in Minnesota to 66 percent in Virginia. The data show that region is associated with the gender distribution of science and mathematics teachers (and high school teachers in general). Thirteen states have more female than male mathematics teachers, and eight of these states are in the Southeast. Six states have more female mathematics teachers than female high school teachers in general: Alabama, Kentucky, Mississippi, New Jersey, North

Figure 9
Gender of Mathematics and Science Teachers (40 States)

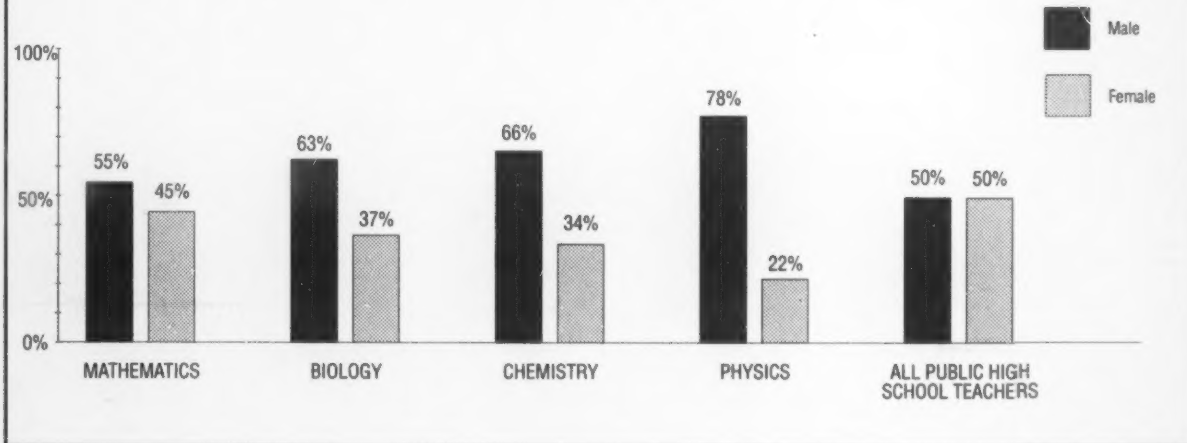
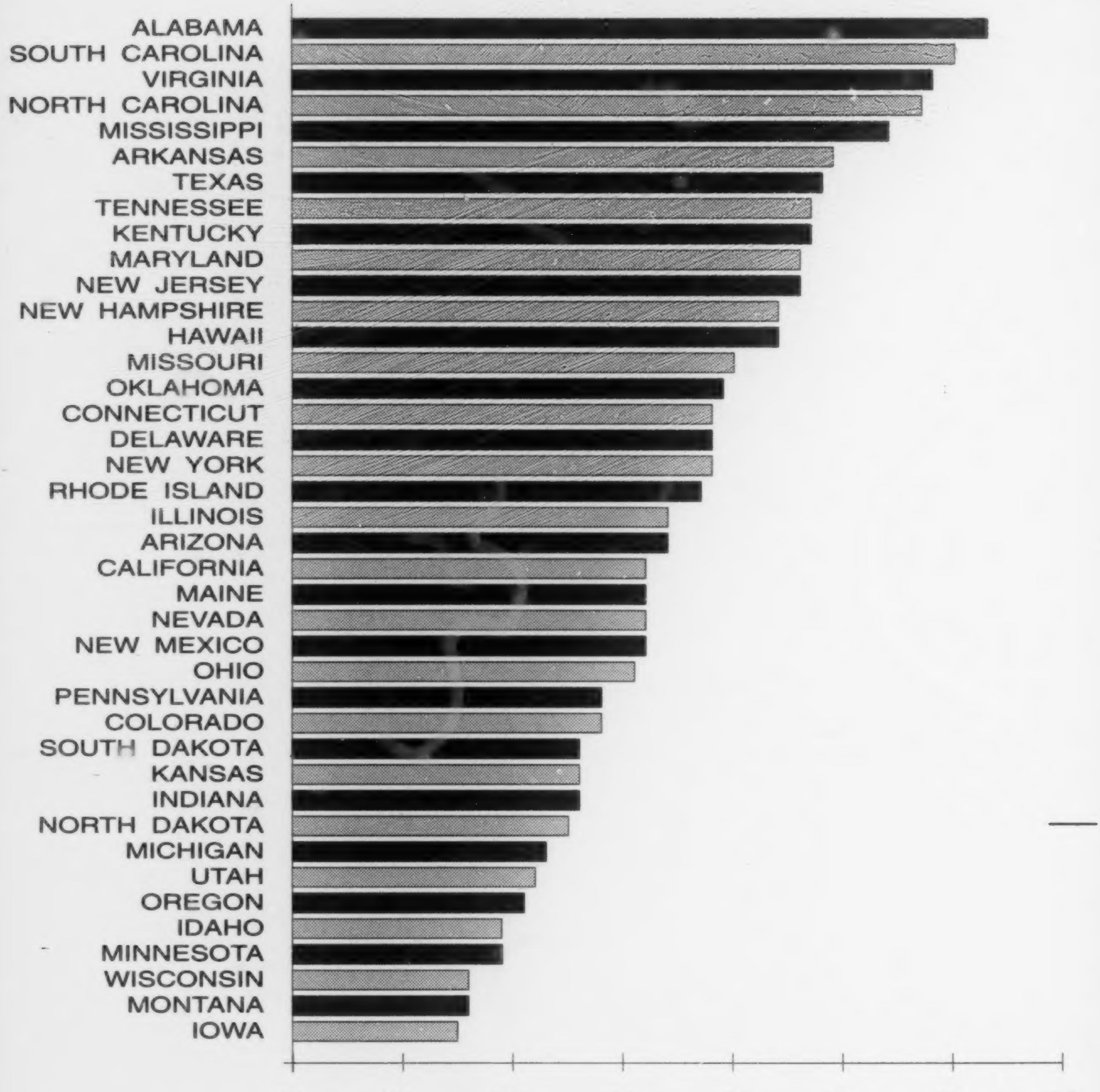


Figure 10
Percent of Biology Teachers That Are Female



Percent of biology teachers that are female
Total (40 States) = 37%

Source: State Departments of Education, Data on Public Schools, Fall 1989
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Table 11
MINORITY TEACHERS IN MATHEMATICS AND SCIENCE BY MINORITY STUDENTS IN STATE

STATE	Percent Minority Students (K–12)	Percent Minority Teachers (9–12)			
		Math	Biology	Chemistry	All High School
Maine	2%*	.2%	0%	0%	.3%
Iowa	6	.4	0	1	1
Idaho	7*	2	1	0	2
Montana	7*	1	1	0	2
Utah	7	2	2	1	3
North Dakota	8	.2	1	1	2
Kentucky	10	2	3	1	4
Indiana	14	3	3	2	4
Kansas	15	3	2	6	9
Rhode Island	16	2	2	5	6
Wisconsin	14	2	2	1	2
Ohio	16	3	5	2	6
Pennsylvania	17	3	3	1	3
Michigan	22	7	3	1	8
Nevada	24	9	7	3	10
Colorado	24	5	6	—	7
Connecticut	24	3	3	2	5
Arkansas	25	10	10	6	10
Oklahoma	25	5	5	4	6
Virginia	27*	13	14	10	15
Delaware	31	8	4	0	11
North Carolina	33	14	16	11	16
New Jersey	34	10	7	5	10
Arizona	36	6	5	—	10
Illinois	34	11	12	7	12
Alabama	37	18	19	17	21
Maryland	38	17	16	—	—
South Carolina	42	22	21	17	20
Texas	50	18	17	11	19
Mississippi	51	26	30	27	31
California	53	18	16	12	18
New Mexico	58	20	19	19	25
Hawaii	77	71	61	67	78
TOTAL (33 states)	32%	11%	10%	7%	11%

Percent minority teachers = sum of four non-white categories of public school teachers from Appendix Tables B-8, B-9.
Minority teachers reported under Biology for Colorado, Arizona, Maryland = All science fields.
Sources: (teachers) State Departments of Education, Fall 1989; (students) NCES Common Core of Data, Public School Universe, Fall 1989; (*) USDE Office for Civil Rights, State Summaries of Projected Data, 1986.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990.

Carolina, South Carolina, and Virginia. In biology, the percentage of female teachers varies from 15 percent in Iowa to 63 percent in Alabama. Figure 10 displays a histogram of the percent of female biology teachers by state. States in the southeast have more female biology teachers than other regions, and states in the midwest have the lowest proportion of female biology teachers. Chemistry and physics have fewer female teachers in most states, but five states have more female than male chemistry teachers (all but Hawaii are in the Southeast). No state has a majority of physics teachers that are female. The proportion of female physics teachers varies from 10 percent (Michigan, Minnesota, Utah) to 49 percent (Alabama).

Race/Ethnicity of Science and Mathematics Teachers. The second indicator of equity in the science and mathematics teaching force is the race/ethnicity of current teachers. The 1985–86 national sample survey showed that approximately eight percent of high school mathematics teachers and 10 percent of science teachers were from racial/ethnic minority groups (Weiss, 1989). Nationally, 30 percent of elementary and secondary students are minorities, and 70 percent are white (NCES, 1989).

As of the 1989–90 school year, state data on the race/ethnicity of science and mathematics teachers (grades 9–12) show the following percentages of minority and white teachers (based on 33 reporting states).

Percent of Minority and White Teachers in Mathematics and Science

	Minority	White
Mathematics	11%	89%
Biology	10	90
Chemistry	7	93
Physics	5	95

The states with the highest proportions of minority teachers, in science and mathematics as well as among all high school teachers, are in the Southeast and Hawaii. There is relatively little variation among mathematics, biology, and chemistry in the percent of minority teachers, although chemistry has slightly fewer minorities in most states. The state data show that except for Hawaii no state has representation of minority teachers which is similar to the racial/ethnic background of students.

By comparison, the statistics for all high school teachers show 11 percent minority and 89 percent white. State-by-state race/ethnicity data are in Appendix Tables B-8, B-9, and B-10.

The proportion of minority high school science and mathematics teachers in each state can be compared with the proportion of minority students. Table 11 provides state-by-state statistics for these comparisons in three teaching fields: mathematics, biology, and chemistry. Among the 33 states that reported teacher race/ethnicity by field and student race/ethnicity, only eleven states had over 10 percent minority teachers in any of the three fields. Of the 20 states with more than 20 percent minority students, only five states have even half as many minority teachers in mathematics, biology, or chemistry as the proportion of minority students (Virginia, Alabama, South Carolina, Mississippi, Hawaii).

Indicators of Teacher Preparation in Subject Area

Two state indicators of teacher preparation are analyzed: (1) the proportion of science and mathematics teachers who are not state certified in assigned teaching fields, i.e., teaching out-of-field, and (2) the proportion of science and mathematics teachers who have a college major in their teaching field. State collected data on teacher assignments by certification status as of October 1, 1989 were reported to CCSSO. A major advantage of using state data on teacher assignments and certification is that the data can be computed from state administrative records and computerized data files, thereby alleviating the need for special surveys of teachers that require teachers' self-report of certification status. Since certification standards for each teaching field differ by state, it is important to consider state-by-state differences in state certification standards. For example, a mathematics teacher with 24 mathematics credits would qualify for certification in Illinois but would be considered out-of-field in Wisconsin which requires 34 credits (see Appendix Table B-11). Statistics on college majors of science and mathematics teachers were produced from analyses of the NCES Schools and Staffing Survey data collected in Spring 1988.

The subject area preparation of teachers in science and mathematics has been found to be a valid, useful measure of teacher quality in these subjects. From their research review, Shavelson, McDonnell, and Oakes (1989) maintained that teacher quality, i.e., the knowledge and skills of the teacher, is an important predictor of teaching quality, and that the teacher's academic knowledge and subject area preparation is related to student learning in certain subjects, particularly science and mathematics. The National Research Council's recent recommendations on needed statistics of precollege science and mathematics teachers includes measures of the amount of preparation in the field of assignment (1990).

Teacher certification for a specific teaching assignment is a policy relevant indicator of the degree to which teachers in a subject area meet basic state requirements for knowledge and preparation. The determination of teacher shortage depends on having a definition of a qualified teacher. Definitions of shortage vary from simply the number of vacancies, (i.e., classrooms for which no teacher was hired), to the number of classes taught by a teacher who has not majored in the field of assignment, to the number of teachers that perceive themselves to be less than well-qualified. State certification by teaching assignment provides a common definition of qualifications to determine current teacher shortages in a state. (Other variables such as student-teacher ratio and teaching vacancies must also be measured to determine overall demand for teachers in a subject area.)

Knowing whether or not a teacher is certified for the courses he/she is teaching does not provide a good measure of teaching quality or even a sufficient measure of a given teachers's preparation in the subject area (Murnane and Raizen, 1988). However, the proportion of teachers who are teaching out-of-field is a useful policy indicator because it is a quantifiable measure of the proportion of teachers in a district or state that do not meet basic qualifications (Shavelson, et al., 1989). Certification has often been used as a working definition of qualified to analyze current teacher shortages in science, mathematics, and other subjects (Darling-Hammond and Hudson, 1989; Oakes, 1990a). A report of the California Commission on the Teaching Profession (1985) found that certification is a useful measure of teacher qualifications when analyzing the percent of non-certified teachers in schools with a high proportion of at-risk students as compared to those with few at-risk students.

The Holmes Group (1986) recommendations for improving the quality of teachers focused on increasing the subject area preparation in teacher education and requiring a masters degree for certification. Some states now require a major in a liberal arts field to obtain teacher certification. The proportion of teachers in science and mathematics who hold college major in their field of teaching provides an indicator of preparation that sets a higher standard than the indicator based on state certification.

Teacher certification and college major are used as indicators of teacher quality in this report. As other state-by-state indicators of quality become available, such as teacher knowledge and skills or teacher instructional practices, they will be incorporated into the state indicators system.

Teacher Certification by Assignment. Thirty states reported results of cross-tabulating state data on teacher assignments by teacher certification status. Figure 11 shows that the percent of teachers assigned to teach a subject for

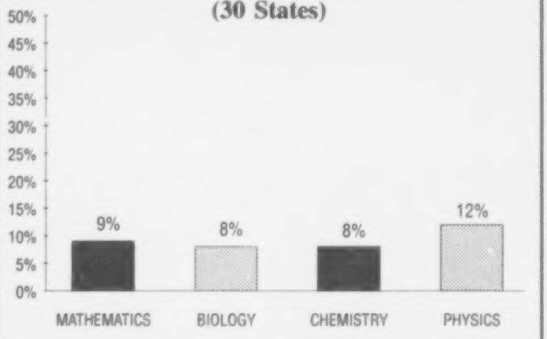


Figure 11
Percent of Mathematics and Science Teachers Assigned Out-of-Field (30 States)

which they are not certified (out-of-field) is nine percent in mathematics, eight percent in biology and chemistry, and 12 percent in physics. These statistics include teachers with primary and secondary assignments. The 30 states represented in these totals include four large states, California, New York, Illinois, and Pennsylvania, but they do not include Florida and Texas (which are expected to report the data in the next reporting cycle).

The 1985–86 national survey of science and mathematics teachers produced data on teachers' certification status. The results showed that 84 percent of mathematics teachers in grades 10–12 and 62 percent in grades 7–9 were state certified in mathematics; and in science, 89 percent of teachers in grades 10–12 and 73 percent of teachers in grades 7–9 were state certified in a field of science (Weiss, 1987).

State-by-state percentages of teachers out-of-field, disaggregated by primary and secondary assignments, are shown in Appendix Tables B-12 through B-15. The data show that states vary widely on the teaching out-of-field indicator. Figures 12 and 13 provide histograms of the state percentages of mathematics and physics teachers that are assigned out-of-field. The total percent out-of-field in mathematics varies from 52 percent in South Dakota and 31 percent in Colorado to zero percent in Connecticut and North Dakota, with the median state at four percent. In biology, the percentage out-of-field varies from 34 percent in Arkansas to zero percent in several states, with the median state at three percent out-of-field. In chemistry, the median state has five percent out-of-field and in physics the median state has 10 percent out of field. States with more than 15 percent of teachers out-of-field in chemistry and physics are Arkansas, California, Illinois, Mississippi, and South Dakota; and Alabama, Delaware, and New York have more than 15 percent out of field in physics. The data show that some of the states with substantial numbers of science and mathematics teachers out-of-field have many small, rural districts (and thus many small high schools), such as South Dakota, Illinois, and Mississippi. States experiencing population growth such as California have high demand for teachers and have more teachers out-of-field.

National statistics on the percent of teachers out-of-field show that less than five percent of teachers with *primary assignments* in science and mathematics are out-of-field (Bobbitt and McMillen, 1990). The state-by-state data on certification status by teachers with primary and secondary assignments (Appendix Tables B-14, B-15) reveal that in many states a significant proportion of chemistry and physics teaching is done by teachers with a secondary assignment in these subjects (a total of 40 percent of chemistry teachers and 61 percent of physics teachers). The data also show that teachers with secondary assignments in chemistry and physics are less likely to be certified to teach in the secondary field. For example, nine percent of secondary assignment physics teachers are out-of-field vs. three percent of primary assignment teachers.

In comparing the proportion of teachers out-of-field by state it is important to consider differences among states in requirements for teacher certification. States vary widely in requirements such as the number of academic course credits and supervised field experience. Appendix Table B-11 lists the requirements in each state by teaching field. In an earlier report on the state science and mathematics indicators (Blank, 1990), the number of college course credits required for certification was analyzed by the percentage of teachers in each state teaching out-of-field. The results showed that states with fewer required course credits tended to have fewer teachers out-of-field, but there were numerous exceptions. The number of districts and schools per state and population trends appeared to be more significant factors in state differences in the proportion of science and mathematics teachers teaching out-of-field.

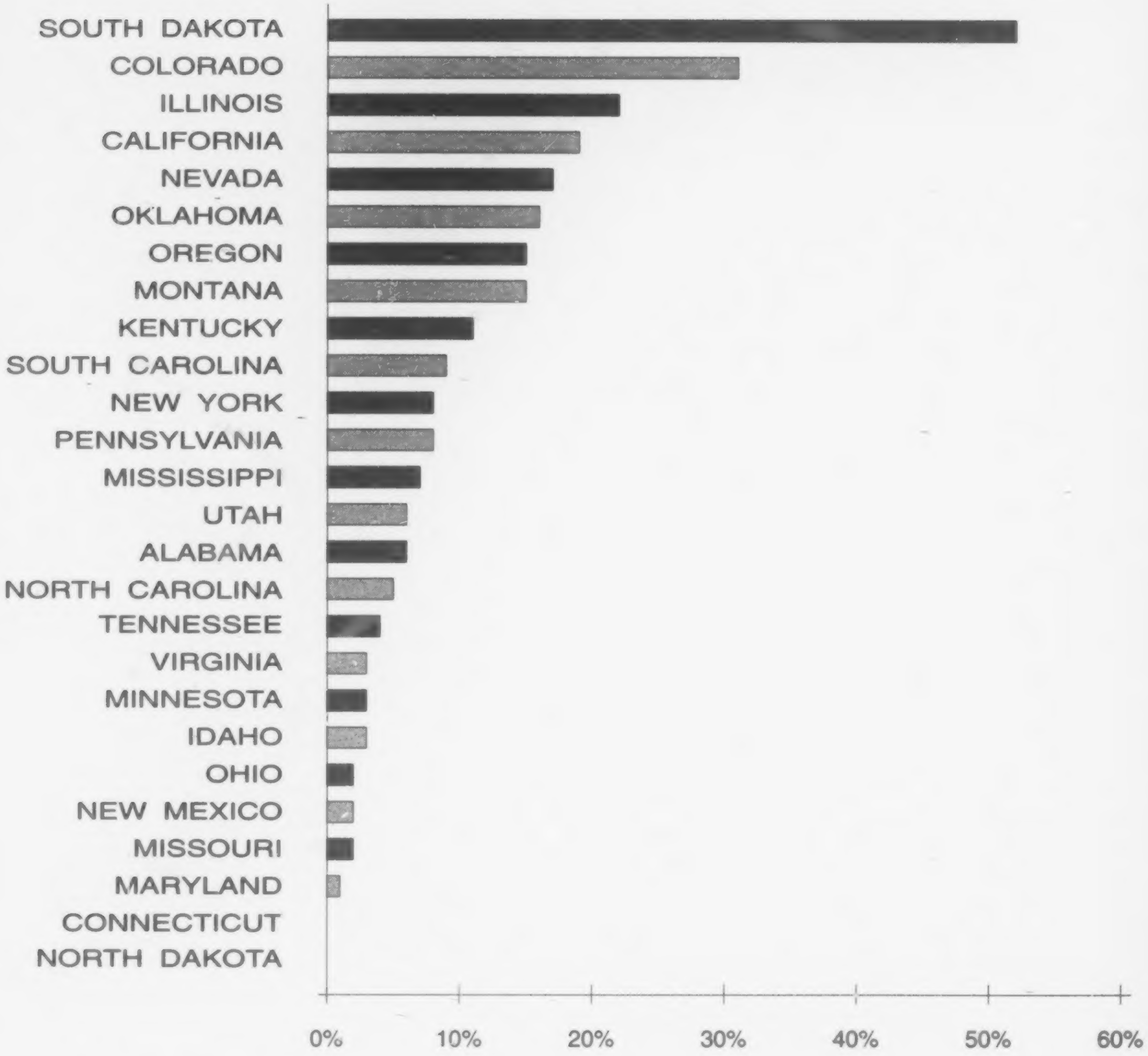
Two-thirds of the states certify science teachers through broad field certification as well as in specific fields of biology, chemistry, physics, etc. States reported teaching assignments by certification according to broad field vs. specific field certification, and the totals show that over a third of science teachers in 30 reporting states have broad field certification. (See Appendix Tables B-13, B-14, B-15 for state figures.)

Percent of Mathematics and Science Teachers with Specific vs. Broad-Field Certification

	Certified Specific Field	Certified Broad Field Science	Assigned Out-of-Field
Mathematics	81%	—	9%
Biology	61	31%	8
Chemistry	57	45	8
Physics	50	38	12

Individual states may be able to increase the number of certified science teachers in more classrooms with a broad field policy. However, as a group, states with broad field science certification do not currently have lower percentages

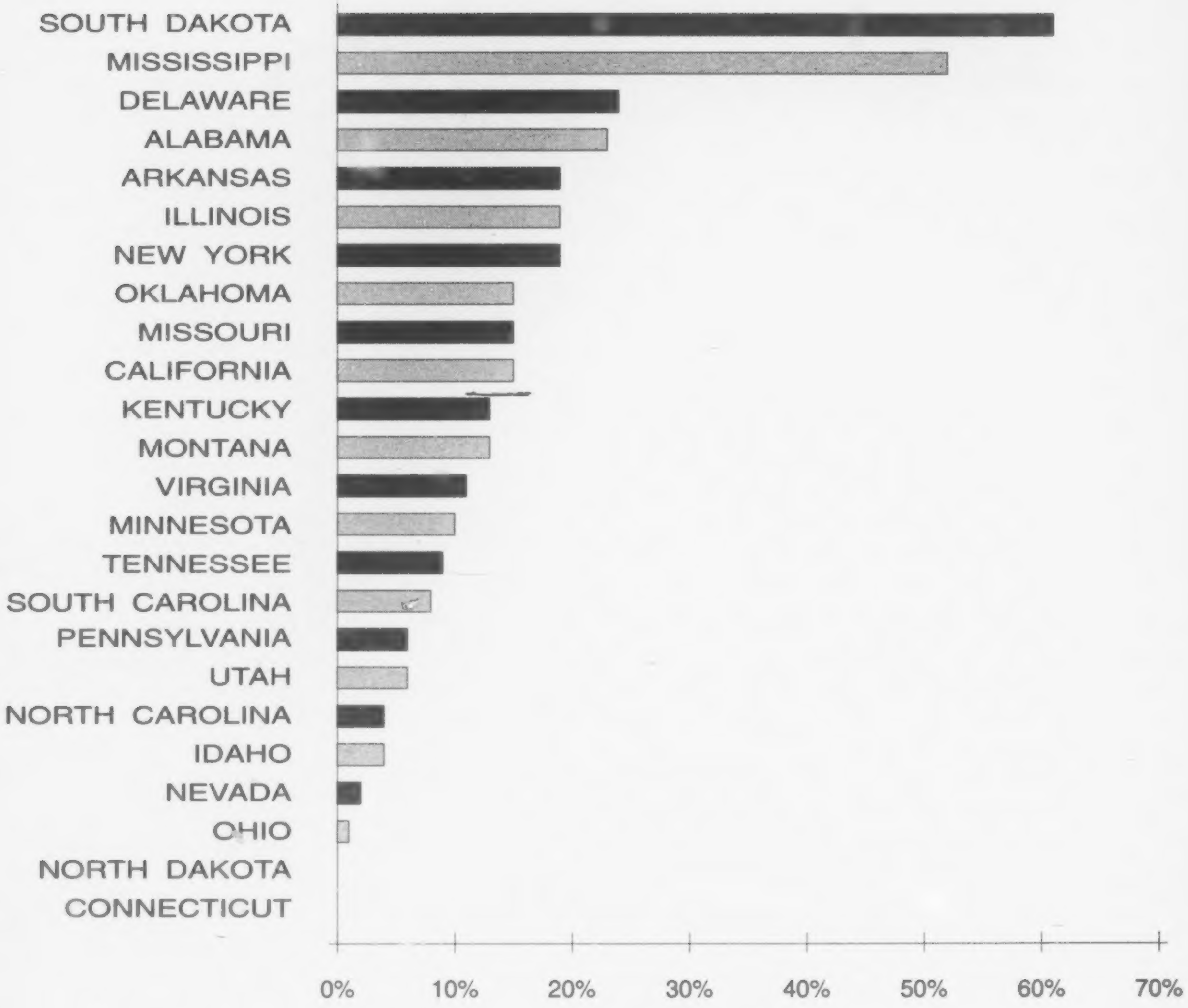
Figure 12
Percent of Mathematics Teachers Assigned Out-of-Field



Percent of teachers assigned to teach mathematics not certified in mathematics
Total (30 States) = 9%

Source: State Departments of Education, Data on Public Schools, Fall 1989
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Figure 13
Percent of Physics Teachers Assigned Out-of-Field



Percent of teachers assigned to teach physics not certified in physics or broad field science
Total (26 States) = 12%

Source: State Departments of Education, Data on Public Schools, Fall 1989
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

of science teachers out-of-field than states with only specific field science certification (Blank, 1990).

College Majors of Teachers. The state-by-state data on science and mathematics teachers with college majors in these fields are from the Schools and Staffing Survey (SASS). State-representative samples of elementary and secondary teachers in public schools were surveyed in Spring 1988. The analyses were conducted by CCSSO. From the SASS data, Table 12 lists the proportion of high school mathematics and science teachers in each state who reported having a college major in these fields.[8]

The results show that for the nation 42 percent of public high school teachers of mathematics have a college major in mathematics, while 47 percent of teachers with their primary assignment in mathematics have a college mathematics major. In science, 54 percent of public high school science teachers have a major in a science field, while 66 percent of teachers with their primary assignment in a science subject have a college major in a science field. The state percentages of mathematics majors among all teachers of mathematics varies from 20 percent (Louisiana) to 62 percent (Kentucky) and the percentage of science majors among all teachers of science vary from 31 percent (Louisiana) to 73 percent (Minnesota, Missouri). Among teachers with their primary assignment in mathematics, the state percentage with a mathematics major varies from 24 percent (Louisiana) to 69 percent (Kentucky), and among teachers with their primary assignment in science, the state percentage with a science major varies from 30 percent (Arkansas) to 86 percent (Missouri). (For the U.S., 63 percent of mathematics teachers majored in mathematics or mathematics education and 64 percent of science teachers majored in science *or* science education. See Appendix Table B-16 for state percentages.)

The college majors of science and mathematics teachers have been analyzed in earlier studies. The 1985–86 national sample survey (Weiss, 1987) showed that 40 percent of mathematics teachers in grades 10–12 had a college major in mathematics and 24 percent of grade 7–9 mathematics teachers had majored in mathematics. In science, 60 percent of grade 10–12 science teachers majored in a science field and 49 percent of grade 7–9 science teachers had a science major. Eighty-four percent of secondary science teachers majored in either a field of science or science education and 25 percent of mathematics teachers majored in either mathematics *or* mathematics education. Oakes (1990a) analyzed the same data by characteristics of schools and found that inner-city schools and schools with more disadvantaged and minority students have fewer teachers with college majors in their teaching field. A national survey of physics teachers (Neuchatz and Covalt, 1988) found that 26 percent have a college degree in physics and only one percent were trained in a field other than science or mathematics. According to this survey, one-third of physics teachers were assigned to physics for the first time or only occasionally taught physics.

INDICATORS OF SCHOOL CONDITIONS

The conditions in schools affect teaching and learning in science and mathematics. School conditions are also important in understanding the needs, or demands, for teachers in science and mathematics. One kind of indicator of school conditions is resources for science and mathematics teaching. National studies have examined access to laboratory equipment and facilities and quality of instructional materials and textbooks (Weiss, 1987; Oakes 1990a), and use of computers, calculators, and laboratories in instruction (Mullis, et al., 1988). This report includes two indicators of school conditions related to the allocation of teachers to classes in science and mathematics. Two state indicators are analyzed: (a) the average class size for high school science and mathematics, and (b) the number of high schools that have teachers assigned in each teaching field. The average for mathematics teachers in grades 10–12 was 21 students per class, while the average for science teachers in grades 10–12 was 22 students per class. These indicators are particularly useful in analyzing the demand for science and mathematics teachers.

Average Class Size. Data from the NCES Schools and Staffing Survey provided state-by-state statistics on the average class size by teaching field. The average is based on teacher self-reports of the number of students they have enrolled in each class period. Table 13 shows state-by-state averages for class size in high school math, science, and English for teachers that have primary assignments in these fields.[9] Average class size for English is used as a comparison statistic because most high school students are enrolled in English classes.

Average High School Class Size (Median State)	
Mathematics	21 students per class
Science	22 students per class
English	22 students per class

The state medians for average class size indicate little difference among the three subjects. There is variation among states in average class size for each subject. California has an average of 29 students per mathematics class, while North Dakota has an average of 14 students per mathematics class. In science, Michigan has 28 students per class, while South Dakota has 15 students per class. The average class size for *all* mathematics and science classes at the state level does not reveal possible differences in class size between lower level courses (possibly larger classes) and upper level courses

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[8] The standard errors for mathematics teachers with majors vary from 2.0% (Idaho) to 8.8% (Pennsylvania). The standard error for the U.S. total is 1.4%. The standard errors for science teachers with majors vary from 4.9% (Wyoming) to 10.2% (Kentucky). The standard error for U.S. total is 1.4%.

[9] The standard errors for class size in mathematics vary from .55 (Texas) to 2.6 (New Mexico). The standard errors for science class size vary from .5 (Georgia) to 2.75 (Mississippi).

Table 12
PERCENTAGE OF MATHEMATICS AND SCIENCE TEACHERS WITH COLLEGE MAJOR IN FIELD
(Grades 9–12, Public Schools)

STATE	Primary Assignment Math % w/Major in Math	All Teachers of Math % w/Major in Math	Primary Assignment Science % w/Major in Science	All Teachers of Science % w/Major in Science
ALABAMA	45%	39%	70%	52%
ALASKA	42	25	65	48
ARIZONA	—	—	46	43
ARKANSAS	45	37	30	41
CALIFORNIA	39	33	68	52
COLORADO	35	30	76	66
CONNECTICUT	52	43	73	65
DELAWARE	—	—	—	—
DIST OF COLUMBIA	—	—	—	—
FLORIDA	29	26	60	56
GEORGIA	57	54	66	54
HAWAII	—	—	—	—
IDAHO	61	33	58	47
ILLINOIS	56	51	61	56
INDIANA	42	37	55	50
IOWA	50	45	66	55
KANSAS	54	44	53	41
KENTUCKY	69	62	67	57
LOUISIANA	24	20	44	31
MAINE	26	22	63	48
MARYLAND	63	58	—	—
MASSACHUSETTS	55	51	68	59
MICHIGAN	53	47	71	56
MINNESOTA	63	54	79	73
MISSISSIPPI	50	49	51	46
MISSOURI	41	40	86	73
MONTANA	—	—	74	54
NEBRASKA	38	32	61	47
NEVADA	—	—	—	—
NEW HAMPSHIRE	—	—	—	—
NEW JERSEY	54	53	76	71
NEW MEXICO	55	54	61	47
NEW YORK	57	49	71	58
NORTH CAROLINA	28	26	63	49
NORTH DAKOTA	29	28	73	61
OHIO	48	44	66	61
OKLAHOMA	34	24	59	41
OREGON	38	31	72	58
PENNSYLVANIA	45	41	60	55
RHODE ISLAND	—	—	—	—
SOUTH CAROLINA	50	47	65	58
SOUTH DAKOTA	47	40	62	38
TENNESSEE	50	46	39	33
TEXAS	46	42	62	51
UTAH	32	24	57	32
VERMONT	—	—	—	—
VIRGINIA	58	57	82	74
WASHINGTON	35	27	59	36
WEST VIRGINIA	45	44	53	47
WISCONSIN	51	49	71	66
WYOMING	32	31	61	39
U.S. TOTAL	47%	42%	66%	54%

—Too few cases for a reliable estimate.
Note: % with majors in mathematics and science does not include mathematics and science education. (see Table B-16)
Source: Schools and Staffing Survey, Public School Teachers National Center for Education Statistics, Spring 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Table 13
AVERAGE CLASS SIZE IN MATHEMATICS AND SCIENCE
(Public High Schools)

STATE	MATH Average Students Per Class	SCIENCE Average Students Per Class	ENGLISH Average Students Per Class
ALABAMA	23	25	25
ALASKA	19	18	18
ARIZONA	—	23	25
ARKANSAS	19	22	19
CALIFORNIA	29	27	28
COLORADO	21	20	22
CONNECTICUT	19	19	18
DELAWARE	—	—	—
DIST OF COLUMBIA	—	—	—
FLORIDA	26	27	23
GEORGIA	26	22	24
HAWAII	—	—	—
IDAHO	18	22	21
ILLINOIS	23	23	23
INDIANA	21	23	22
IOWA	16	19	19
KANSAS	15	19	16
KENTUCKY	25	25	24
LOUISIANA	22	24	22
MAINE	17	17	23
MARYLAND	24	—	28
MASSACHUSETTS	20	22	22
MICHIGAN	23	28	25
MINNESOTA	23	21	23
MISSISSIPPI	24	26	24
MISSOURI	19	20	21
MONTANA	—	22	19
NEBRASKA	17	19	23
NEVADA	—	—	—
NEW HAMPSHIRE	—	—	—
NEW JERSEY	18	20	19
NEW MEXICO	25	22	25
NEW YORK	21	23	23
NORTH CAROLINA	23	24	23
NORTH DAKOTA	14	16	19
OHIO	22	23	23
OKLAHOMA	22	18	20
OREGON	21	21	22
PENNSYLVANIA	24	23	22
RHODE ISLAND	—	—	—
SOUTH CAROLINA	21	22	22
SOUTH DAKOTA	12	15	16
TENNESSEE	24	25	25
TEXAS	21	22	22
UTAH	24	26	27
VERMONT	—	—	—
VIRGINIA	21	22	22
WASHINGTON	26	26	24
WEST VIRGINIA	21	21	24
WISCONSIN	20	21	22
WYOMING	15	16	16
MEDIAN	21	22	22

Note: Class sizes reported by teachers with primary assignments in subjects.
—Too few cases for a reliable estimate.
Source: Schools and Staffing Survey (SASS), Public School Teachers NCES, Spring 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

(possibly smaller classes). This degree of specificity could not be obtained with the sample survey data at the state level. (The data are available in SASS for such analyses at the national level.)

National figures for class size in science and mathematics were reported from the 1985–86 national survey of teachers. At that time, the average for mathematics teachers in grades 10–12 was 21 students per class, while the average for science teachers in grades 10–12 was 22 students per class.

Number of Teachers and Schools Per State. The number of science and mathematics teachers in each teaching field can be compared with the number of high schools in a state to determine the proportion of schools that are able to offer science and mathematics courses in each field. National surveys have analyzed the proportion of schools that offer advanced science and mathematics courses (Weiss, 1987; Neuchatz and Covalt, 1988; Oakes; 1990a). Neuchatz and Covalt found that 83 percent of high schools in the nation offer physics, and these schools include 96 percent of students. However, only 66 percent of schools offer physics each year.

Table 14 shows the total number of teachers (primary or secondary assignment) in mathematics, biology, chemistry, and physics arrayed by the number of high schools per state. A quick review of the state data shows that the school to teachers comparison is particularly useful for analyzing the demand for teachers in chemistry and physics. In many states the number of teachers is close to the number of schools, and in states that have fewer teachers than schools it is likely that some schools are not offering chemistry or physics. The school to teacher ratios reveal that:

- 11 of 41 reporting states have more high schools than chemistry teachers
- 28 of 41 reporting states have more high schools than physics teachers
- The number of physics teachers is less than one-half the number of high schools in Illinois, Michigan, Mississippi New Hampshire, Oklahoma, and Utah.

Several of the states with more high schools than physics teachers reported few or no teachers teaching out-of-field, such as Idaho, Nevada, North Dakota, Ohio, and Utah (see Appendix Table B-15). In these states, a state policy may prevent assignment of non-certified teachers to shortage fields, or school districts may not offer a course if there is not a certified teacher.

One caveat in comparing the number of schools and teachers in a state to identify shortages of teachers is that the problem may be overstated in some states. Chemistry and physics teachers are shared among schools in some districts, and this cooperative arrangement is not accounted for in the teacher per school ratio. Some schools alternate teaching chemistry and physics each year. Conversely, the schools to teachers ratio may understate the problem of shortages in states that have large high schools with more than one physics or chemistry teacher and small schools with none (the state average would indicate that each school has a teacher).

Table 14

NUMBER OF PUBLIC HIGH SCHOOLS BY NUMBER OF MATHEMATICS AND SCIENCE TEACHERS (Grades 9–12)

STATE	Public High Schools	TOTAL NUMBER OF TEACHERS			
		Mathematics	Biology	Chemistry	Physics
ALABAMA	245	1,597	809	380	305
ARKANSAS	337	(P) 650	518	283	220
CALIFORNIA	1,256	9,684	3,733	1,308	868
CONNECTICUT	165	1,453	620	373	243
DELAWARE (P)	33	240	55	17	41
FLORIDA	319	—	3,832	1,096	632
HAWAII	32	831	153	49	39
IDAHO	129	649	270	129	104
ILLINOIS	666	3,745	1,312	654	293
INDIANA	345	2,298	1,003	491	368
IOWA	407	1,487	700	427	390
KANSAS	347	1,179	653	370	262
KENTUCKY	258	1,659	689	345	220
LOUISIANA	251	3,565	816	442	241
MAINE	110	796	357	203	173
MASSACHUSETTS	292	3,513	764	466	269
MICHIGAN	599	3,339	839	434	261
MINNESOTA	428	1,811	715	475	366
MISSISSIPPI	172	719	398	141	46
MISSOURI	497	1,999	986	574	361
MONTANA	171	535	236	154	132
NEVADA	56	673	213	69	41
NEW HAMPSHIRE	69	600	228	59	32
NEW JERSEY (P)	328	4,375	887	337	82
NEW MEXICO	120	643	301	121	78
NEW YORK	713	7,853	5,180	1,864	1,158
NORTH CAROLINA	320	2,966	1,181	553	331
NORTH DAKOTA	225	471	262	174	125
OHIO	769	4,254	1,695	985	751
OKLAHOMA	479	1,674	901	481	240
OREGON	204	1,222	338	158	106
PENNSYLVANIA	587	5,704	1,755	1,016	670
RHODE ISLAND (P)	40	418	155	77	44
SOUTH CAROLINA	195	1,853	615	324	210
SOUTH DAKOTA	177	707	230	151	125
TENNESSEE	255	1,872	709	357	238
TEXAS	1,054	9,834	3,951	1,562	909
UTAH	134	1,114	505	105	69
VIRGINIA	276	3,114	994	543	323
WEST VIRGINIA	145	906	386	182	122
WISCONSIN	431	1,960	838	522	374
WYOMING	76	464	180	125	98
TOTAL (42 states)	13,712	94,434	40,962	18,576	11,960

Total Teachers = Teachers with primary or secondary assignment in subject.
High School = Low grade 7-12, high grade 12.
(P) Only teachers with primary assignment reported.
Source: State Departments of Education, Data on Public Schools, Fall 1989; National Center for Education Statistics, Fall 1989, N. Carolina, Fall 1988
Council of Chief State School Officers, State Education Asssessment Center, Washington, DC, 1990

STATE SCIENCE AND MATHEMATICS INDICATORS AND POLICY ISSUES

The initial results from state-by-state indicators of science and mathematics education provide findings to address at least five policy issues: (1) How much science and mathematics education are students being taught in our schools, and what is the level of instruction? (2) What has been the effect of higher state graduation requirements on science and mathematics education? (3) How much progress is being made in closing the gender gap in science and mathematics education? (4) What is the current supply of science and mathematics teachers, and what shortages exist or can be anticipated? (5) How well prepared are science and mathematics teachers?

This report also addresses questions about the development and use of state-comparative data and demonstrates how a system of state indicators can be used to track progress over time in assessing the quality of science and mathematics education.

Amount and Level of Science and Mathematics Instruction. State data on course enrollments as of the 1989–90 school year were used to estimate the proportion of high school students that take gatekeeper courses by the time they graduate. In *mathematics,* an estimated nine percent of students take calculus, 49 percent take algebra 2, and 81 percent take algebra 1. In *science,* an estimated 20 percent of students take physics, 45 percent take chemistry, and over 95 percent take biology. States vary in the estimated rates of course taking. For example, course taking in algebra 2 varies by state from 65 percent to 33 percent, and course taking in chemistry varies from 62 percent to 33 percent. In 28 states that reported data on course taking at the middle/junior high level, about one of every eight students in eighth grade (13%) were enrolled in an algebra 1 or accelerated mathematics course in 1989–90. This is the traditional point of entry into a college preparatory mathematics course sequence culminating in calculus. The state enrollments in mathematics at this course level vary from 3 percent to 34 percent of eighth grade students. The amount of time spent on science and mathematics in elementary grades provides an indicator of instructional emphasis. Elementary teachers spend about three hours per week on science in grades 4–6, and they spend about 4.9 hours per week on mathematics in grades 4–6, based on 1988 survey data from teachers. The state figures for mathematics vary from 4.1 hours to 5.5 hours per week, and the time spent on science varies from 2.2 to 4.1 hours per week.

State Policies and Course Taking in Science and Mathematics. State legislatures and state boards of education which increased graduation requirements in the 1980s expected that course taking in science and mathematics would increase. The state indicators on high school course taking as of 1989–90 confirm other research showing increased enrollments in science and mathematics during the 1980's when state graduation requirements were raised in many states. State course taking rates show somewhat higher enrollments at all levels but the largest increases were at the level of algebra 1 (to 81% of students) and first year biology (to 95% of students).

Most states did not specify the level of course taking students needed to take, but subsequent analyses of state policy initiatives have raised this issue. Eleven states that now require from two and a half to three credits of *mathematics* have an average of 10 percent more students taking mathematics courses than states requiring two credits or less. The high requirement states average only two percent more students in upper level mathematics courses. Thus, the results from the initial year of state indicators suggest that a state graduation requirement above two credits has only a small effect on increasing the number of students taking upper level mathematics courses. Tracking course taking rates over time in individual states will allow us to address more authoritatively this question.

Most states that increased the graduation requirement for *science* in the 1980s changed from a one credit to a two credit requirement (currently 38 states require two credits). Five states now require from two and a half to three *science* credits. These five states have a median of 9 percent more students enrolled in science than states requiring two or fewer credits. The high requirement states have a median of four percent more students taking upper level science courses than states requiring two or fewer credits. This finding gives some evidence that a science graduation requirement above two credits is related to more upper level course taking, but the data are not conclusive because of the small number of states with higher science requirements.

States that raised their science requirement to two credits in the 1980s may have increased the rate of science course taking. The 1989–90 data show there is a high degree of variation among these states in course taking rates. With subsequent biennial reports on state science and mathematics indicators, the trends in course taking by graduation requirements can be assessed for individual states.

Gender Differences. The state data on course enrollments by student gender confirm findings from other research that girls have increased their study in science and mathematics in high school. Based on data from 16 states, girls and boys have the same rates of enrollment in mathematics up to advanced courses at the level of trigonometry and calculus, where boys still have higher enrollments. In science, the rates of enrollment also are the same up to the advanced courses. Boys have higher enrollments in physics and advanced physical science courses, and girls have higher enrollments in advanced biology courses. The state data indicate that course taking in high school science and mathematics is increasing among girls, but that there are still differences in enrollments at the advanced levels of mathematics and in specific science fields. The 16 states are not necessarily representative of all the states, although they do include large and small states and states from all regions of the country.

Teacher Supply and Demand. The state data on science and mathematics teachers indicate three findings concerning teacher shortages: the national problem is not as severe as predicted in the early 1980s, shortages are highly variable by state, and answers concerning supply and demand of science and mathematics teachers vary with the criterion of teacher quality that is used.

The current age distribution of science and mathematics teachers indicates that nationally there is little likelihood of greater shortages of teachers in these subjects than in other subjects. The fields of chemistry and physics have slightly more teachers over age 50 than other teaching fields, but all the mathematics and science fields have more younger teachers than the average for high school teachers. A shortage of science and mathematics teachers can be anticipated in a few states that have much higher percentages of their teaching force over age 50 than other states.

The majority of science and mathematics teachers are male, but the gender distribution varies by field from 45 percent female in mathematics to 22 percent female in physics. The proportion of female teachers varies significantly by state, for example, in mathematics, from 21 percent to 69 percent female, and in physics, from 10 percent to 49 percent female. States in the southeast have higher proportions of female science and mathematics teachers as well as more female high school teachers in general. The state-by-state data on gender allow states and school districts to identify where they may need to concentrate efforts in recruiting more female (or male) science and mathematics teachers.State data on the race/ethnicity of science and mathematics teachers show that there are severe shortages of minority science and mathematics teachers if a state's policy goal is to have the proportion of race/ethnic minority teachers match the proportion of race/ethnic minority students. However, the fields of science and mathematics are not any better (or worse) in training and recruiting minority science and mathematics teachers than other teaching fields.

Teacher Quality. The state data on certification status of science and mathematics teachers indicate that at the high school level the problem of out-of-field teaching is not an enormous national problem. However, there are two important qualifications: first, the state-by-state indicators show that some states have over one third of teachers in mathematics and the physical sciences teaching out-of-field, and second, some states have very few teachers assigned out-of-field but there are schools with no teachers in chemistry and physics.

If the proportion of teachers with a college major in science and mathematics is used as a criterion of quality of teacher preparation, there are some states with a majority of well-prepared teachers in their subject. But, there are other states with relatively few teachers with majors in their subject. About half of all high school mathematics and science teachers in the U.S. have a college major in their assigned field. The ratio is higher among those teachers with their primary assignments in mathematics and science. In most states, school districts are able to hire and assign state certified science and mathematics teachers but many of these teachers do not meet higher standards for preparation such as college major in the assigned field or standards set by the professional societies.

There are two other aspects of supply, demand, and quality of science and mathematics teachers that were not addressed by the state data. First, the problem of out-of-field teaching is probably more severe among middle school/junior high science and mathematics teachers (based on discussions with state specialists). Second, the state indicators do not include data on the teachers knowledge and skills in their subject or their teaching practices. These data, when available, would provide a better picture of the quality of our teachers and needs for improvement.

Uses of State Level Indicators. The state indicators of science and mathematics education are best used in combination with each other since they were conceived and developed within a comprehensive model of science and mathematics education. For example, teacher shortages in a state can be examined by analyzing state data on: teacher supply (indicated by age, gender, and race/ethnicity), teacher preparation (indicated by percent teaching out-of-field and college majors), demand for teachers (students per teacher, number of schools compared to number of teachers), as well as course taking rates and trends. Another example of use of an indicators model will be analyzing student achievement scores in relation to state data on science and mathematics instruction, course taking, and teacher characteristics, when achievement data are available. State indicators of science and mathematics can also be used individually at national and state levels to assess specific questions such as gender differences in science and mathematics course taking, the relationship of state policies to course taking, or the proportion of current teachers teaching without state certification. The indicators in this report, which are based on state data, can be analyzed within a state to produce district-by-district or school-by-school results.

The main purpose of the CCSSO science and mathematics indicators system is to examine national and state-by-state trends in science and mathematics in relation to state policies and state program initiatives. The state data have been reported and analyzed using state level statistics. One of the limitations of this approach is that state averages or state aggregate totals cannot reveal the degree of variation within a state. For example, Oakes' (1990a) analyses of national survey data on science and mathematics teachers using characteristics of schools and districts revealed significantly poorer preparation of science and mathematics teachers in inner-city schools and schools with more disadvantaged and minority students. Indicators of course taking, teaching load, and teacher preparation are likely to differ by district and school characteristics. Thus, within-state analyses of these indicators are needed.

Development of State Indicators System. The results from the initial year of the CCSSO state indicators on science and mathematics education indicators show that state collected data can be reported with common definitions and categories, and that the data can produce cross-state analyses. An important product of the work with state representatives in planning an indicator of course enrollments is a taxonomy of science and mathematics course categories and common definitions for these categories (CCSSO, 1989b). The taxonomy and definitions provided reliability and consistency in coding and analyzing state data for 1989–90 data, and they will provide a sound basis for reporting and comparing indicators over time. The results from 1989–90 state data show that course enrollments can be a useful indicator for analyzing curriculum policies and the implementation of policies and programs in schools. Current plans are for biennial state reporting on the course enrollment and teacher indicators. Additional cycles of data reporting by states are expected to increase the number of reporting states to 50 and to provide the basis for trends analyses with the indicators. The next reporting cycle will also allow states to improve the accuracy and completeness of the data collected from teachers, schools, and districts. CCSSO is collaborating with NSF and NCES in planning improved indicators of teacher quality, such as teacher instructional practices and professional development, and indicators of curriculum content at specific grade and course levels.

As education decision-makers ask for improved data and statistics to track progress toward the national educational goals as well as state and district goals, the state indicators system developed by CCSSO will yield important information. As with the indicators in this report, additions of other state science and mathematics indicators will reflect the policy and program concerns of state, national, and local decision-makers, with the design and selection of indicators based on research. This report illustrates how state indicators on measures of policies, instruction, teachers, and schools can be used to inform education decision-makers while also identifying research questions that should be analyzed further using more complex models.

APPENDIX A

Tables with Course Enrollments in Public Schools by State

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Notes for all Appendix A Tables:

— Data not available from state.
Total = Sum of students taking a course (or courses in a category) among the states reporting data.
Median = The median state percentage of students taking a course.
All data on enrollments in public schools.

Appendix Table A-1
STATE REQUIREMENTS IN MATHEMATICS AND SCIENCE FOR HIGH SCHOOL GRADUATION: 1989

	CREDITS FOR REGULAR DIPLOMA		CREDITS FOR ADVANCED/HONORS DIPLOMA	
STATE	Mathematics	Science	Mathematics	Science
ALABAMA	2	2	3	3
ALASKA	2	2		
ARIZONA	2	2		
ARKANSAS	5 combined			
CALIFORNIA	2	2		
COLORADO	Local board			
CONNECTICUT	3	2		
DELAWARE	2	2		
DIST. OF COLUMBIA	2	2		
DODDS	2	2		
FLORIDA	3	3	4	4
GEORGIA	2	2	3	3
HAWAII	2	2		
IDAHO	2	2		
ILLINOIS	2	1		
INDIANA	2	2	4	3
IOWA	Local board			
KANSAS	2	2		
KENTUCKY	3	2	4	3
LOUISIANA	3	3		
MAINE	2	2		
MARYLAND	3	2	3	3
MASSACHUSETTS	Local board			
MICHIGAN	Local board			
MINNESOTA	1	1		
MISSISSIPPI	2	2		
MISSOURI	2	2	3	3
MONTANA	2	1		
NEBRASKA	Local board			
NEVADA	2	2		
NEW HAMPSHIRE	2	2		
NEW JERSEY	3	2		
NEW MEXICO	3	2		
NEW YORK	2	2	2	2
NORTH CAROLINA	2	2		
NORTH DAKOTA	2	2		
OHIO	2	1		
OKLAHOMA	2	2		
OREGON	2	2		
PENNSYLVANIA	3	3		
PUERTO RICO	2	2		
RHODE ISLAND	2	2	3	2
SOUTH CAROLINA	3	2		
SOUTH DAKOTA	2	2		
TENNESSEE	2	2	3	3
TEXAS	3	2	3	3
UTAH	2	2		
VERMONT	5 combined			
VIRGINIA	5 combined		3	3
VIRGIN ISLANDS	2	2		
WASHINGTON	2	2		
WEST VIRGINIA	2	2		
WISCONSIN	2	2		
WYOMING	Local board			
TOTAL	2.5 to 3 = 13 states 2 credits = 34 < 2 = 7	2.5 to 3 = 6 states 2 credits = 38 < 2 = 10		

Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1989.

Appendix Table A-2
COURSE ENROLLMENTS IN MATHEMATICS AS A PERCENT OF STUDENTS IN GRADES 9–12 (October 1989)

STATE	Total Students 9–12	Review & Informal Math	Formal Math Level 1 (Algebra 1)	Formal Math Levels 2–5 (Geom.-Calc.)	Other Math	TOTAL MATH
ALABAMA	197,613	28%	17%	28%	—	73%
ALASKA	27,582	—	—	—	—	—
ARIZONA	155,919	—	—	—	—	—
ARKANSAS	122,798	37	22	31		90
CALIFORNIA	1,269,871	22	22	29	6	79
COLORADO	153,098	—	—	—	—	—
CONNECTICUT	123,168	34	15	38	1	88
DELAWARE	27,109	38	15	33	—	86
DIST OF COLUMBIA	18,949	28	17	30	—	75
FLORIDA	468,910	46	18	29	—	93
GEORGIA	298,109	—	—	—	—	—
HAWAII	42,828	53	12	21	0	87
IDAHO	57,651	16	23	38	5	81
ILLINOIS	484,138	16	19	33	2	70
INDIANA	275,914	31	16	33	—	80
IOWA	132,797	20	24	43	—	86
KANSAS	114,515	28	17	32	3	80
KENTUCKY	175,035	34	19	35	—	88
LOUISIANA	201,564	13	29	43	—	85
MAINE	60,656	—	—	—	—	—
MARYLAND	185,535	33	19	42	2	96
MASSACHUSETTS	235,350	—	—	—	—	—
MICHIGAN	431,833	—	—	—	—	—
MINNESOTA	211,046	12	21	41	—	74
MISSISSIPPI	126,948	24	21	38	—	83
MISSOURI	229,868	19	23	36	2	81
MONTANA	40,736	23	24	41	—	88
NEBRASKA	76,693	17	19	36	6	78
NEVADA	49,357	26	22	26	0	73
NEW HAMPSHIRE	46,964	—	—	—	—	—
NEW JERSEY	293,273	—	—	—	—	—
NEW MEXICO	76,062	38	28	30	0	96
NEW YORK	708,794	30	19	34	7	90
NORTH CAROLINA	310,919	32	18	37	—	88
NORTH DAKOTA	32,896	15	24	44	—	84
OHIO	524,832	28	19	36	2	85
OKLAHOMA	156,971	19	23	34	2	78
OREGON	131,291	—	—	—	—	—
PENNSYLVANIA	480,491	14	23	46	—	83
RHODE ISLAND	36,882	—	—	—	—	—
SOUTH CAROLINA	172,465	45	16	34	2	97
SOUTH DAKOTA	33,366	—	—	—	—	—
TENNESSEE	229,539	24	21	28	1	74
TEXAS	885,269	32	23	35	0	91
UTAH	111,437	—	—	—	—	—
VERMONT	23,656	—	—	—	—	—
VIRGINIA	272,940	29	21	40	0	91
WASHINGTON	224,414	—	—	—	—	—
WEST VIRGINIA	96,398	30	17	30	4	81
WISCONSIN	230,394	34	22	29	—	85
WYOMING	26,927	33	14	25	1	73
TOTAL (36 states)		27%	21%	34%	2%	84%

Note: Review & Informal=general math, applied math, pre-algebra
Formal Levels 2-5=geometry, algebra 2, trigonometry, calculus, AP calculus
Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina and Wisconsin, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table A-3
COURSE ENROLLMENTS IN SCIENCE AS A PERCENT OF STUDENTS IN GRADES 9–12 (October 1989)

STATE	Total Students 9–12	Introductory Courses	Biology 1st Year	Chemistry, Physics, & Advanced	Other Science	TOTAL SCIENCE
ALABAMA	197,613	23%	27%	18%	0%	69%
ALASKA	27,582	—	—	—	—	—
ARIZONA	155,919	—	—	—	—	—
ARKANSAS	122,798	37	28	11	—	76
CALIFORNIA	1,269,871	17	24	15	3	59
COLORADO	153,098	—	—	—	—	—
CONNECTICUT	123,168	22	25	30	4	81
DELAWARE	27,[illegible]99	30	27	21	0	78
DIST OF COLUMBIA	18,949	25	22	16	1	63
FLORIDA	468,910	30	27	28	2	87
GEORGIA	298,109	—	—	—	—	—
HAWAII	42,828	25	22	20	3	71
IDAHO	57,651	18	21	17	4	60
ILLINOIS	484,138	15	20	19	.7	55
INDIANA	275,914	22	25	24	1	71
IOWA	132,797	20	28	23	0	71
KANSAS	114,515	25	28	21	4	78
KENTUCKY	175,035	25	25	23	—	73
LOUISIANA	201,564	29	24	18	5	80
MAINE	60,656	—	—	—	—	—
MARYLAND	185,535	19	27	28	5	78
MASSACHUSETTS	235,350	—	—	—	—	—
MICHIGAN	431,833	—	—	—	—	—
MINNESOTA	211,046	22	25	23	5	74
MISSISSIPPI	126,948	10	31	35	0	76
MISSOURI	229,868	28	22	27	2	78
MONTANA	40,736	22	25	24	1	72
NEBRASKA	76,693	23	27	16	4	70
NEVADA	49,357	13	17	14	5	49
NEW HAMPSHIRE	46,964	—	—	—	—	—
NEW JERSEY	293,273	—	—	—	—	—
NEW MEXICO	76,062	25	27	14	1	67
NEW YORK	708,794	26	27	24	6	83
NORTH CAROLINA	310,919	27	26	16	1	71
NORTH DAKOTA	32,896	28	27	25	2	82
OHIO	524,832	25	25	20	3	72
OKLAHOMA	156,971	23	24	13	5	65
OREGON	131,291	—	—	—	—	—
PENNSYLVANIA	480,491	21	30	27	7	85
RHODE ISLAND	36,882	—	—	—	—	—
SOUTH CAROLINA	172,465	28	25	18	1	72
SOUTH DAKOTA	33,366	—	—	—	—	—
TENNESSEE	229,539	29	23	16	1	69
TEXAS	885,269	24	27	17	1	69
UTAH	111,437	—	—	—	—	—
VERMONT	23,656	—	—	—	—	—
VIRGINIA	272,940	25	25	25	0	76
WASHINGTON	224,414	—	—	—	—	—
WEST VIRGINIA	96,398	27	25	21	2	75
WISCONSIN	230,394	24	25	28	2	79
WYOMING	26,927	23	22	18	6	69
TOTAL (36 states)		23%	25%	21%	3%	72%

Note: Introductory Courses=earth, physical, and general sciences first year

Chemistry/Physics & Advanced=biology second year, earth science second year, chemistry and physics, first and second years

Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina and Wisconsin, Fall 1988

Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table A-4
STUDENTS TAKING REVIEW AND INFORMAL MATHEMATICS (October 1989) AS A PERCENT OF STUDENTS IN GRADES 9–12

		REVIEW MATHEMATICS						INFORMAL MATHEMATICS					
STATE	Total Students 9–12	Level 1 (General, Basic)	% 9–12	Level 2 (Consumer, Applied)	% 9–12	Levels 3&4 (General, 3 & 4)	% 9–12	Level 1 (Pre-Algebra)	% 9–12	Level 2 (Basic Geom.)	% 9–12	Level 3 (Basic Alg. 2)	% 9–12
ALABAMA	197,613	25,133	13%	20,225	10%	—	—	9,310	5%	—	—	—	—
ALASKA	27,582	—	—	—	—	—	—	—	—	—	—	—	—
ARIZONA	155,919	—	—	—	—	—	—	—	—	—	—	—	—
ARKANSAS	122,798	16,601	14%	—	—	20,316	17%	7,903	6%	697	1%	—	—
CALIFORNIA	1,269,871	251,144	20%	29,311	2%	—	—	—	—	—	—	—	—
COLORADO	153,098	—	—	—	—	—	—	—	—	—	—	—	—
CONNECTICUT	123,168	9,364	8%	6,283	5%	4,230	3%	12,988	11%	7,785	6%	1,653	1%
DELAWARE	27,109	3,642	13%	3,174	12%	19	0%	2,797	10%	722	3%	70	.2%
DIST OF COLUMBIA	18,949	4,338	23%	927	5%	—	—	—	—	—	—	53	.2%
FLORIDA	468,910	70,448	15%	84,182	18%	530	.1%	54,285	12%	5,137	1%	—	—
GEORGIA	298,109	—	—	—	—	—	—	—	—	—	—	—	—
HAWAII	42,828	6,699	16%	9,639	23%	421	1%	4,569	11%	1,130	3%	450	1%
IDAHO	57,651	2,308	4%	985	2%	1,570	3%	4,130	7%	—	—	—	—
ILLINOIS	484,138	23,709	5%	19,489	4%	1,071	.2%	28,135	6%	3,532	.7%	1,689	.3%
INDIANA	275,914	26,968	10%	23,522	9%	—	—	24,368	9%	3,433	1%	5,925	2%
IOWA	132,797	9,927	7%	7,042	5%	1,014	1%	7,946	6%	—	—	—	—
KANSAS	114,515	6,066	5%	6,388	6%	2,643	2%	12,707	11%	1,992	2%	2,478	2%
KENTUCKY	175,035	18,800	11%	15,939	9%	7,469	4%	14,261	8%	2,663	2%	518	.2%
LOUISIANA	201,564	3,009	1%	18,836	9%		0%	4,360	2%	—	—	—	—
MAINE	60,656	—	—	—	—	—	—	—	—	—	—	—	—
MARYLAND	185,535	18,089	10%	12,976	7%	11,232	6%	15,659	8%	2,058	1%	959	1%
MASSACHUSETTS	235,350	—	—	—	—	—	—	—	—	—	—	—	—
MICHIGAN	431,833	—	—	—	—	—	—	—	—	—	—	—	—
MINNESOTA	211,046	16,846	8%	7,739	4%	—	—	—	—	—	—	—	—
MISSISSIPPI	126,948	12,035	9%	11,605	9%	—	—	7,047	6%	—	—	—	—
MISSOURI	229,868	33,826	15%	9,426	4%	—	—	—	—	—	—	—	—
MONTANA	40,736	2,911	7%	2,163	5%	2,232	5%	2,257	6%	3	0%	0	0%
NEBRASKA	76,693	11,316	15%	1,927	3%	—	—	—	—	—	—	—	—
NEVADA	49,357	2,657	5%	4,010	8%	1,050	2%	4,724	10%	69	.1%	99	.2%
NEW HAMPSHIRE	46,964	—	—	—	—	—	—	—	—	—	—	—	—
NEW JERSEY	293,273	—	—	—	—	—	—	—	—	—	—	—	—
NEW MEXICO	76,062	17,020	22%	5,319	7%	—	—	6,615	9%	—	—	—	—
NEW YORK	708,794	110,510	16%	28,076	4%	2,324	.3%	52,035	7%	15,362	2%	6,940	1%
NORTH CAROLINA	310,91[illegible]	37,938	12%	31,808	10%	2,737	1%	27,829	9%	—	—	—	—
NORTH DAKOTA	32,896	1,042	3%	2,021	6%	—	—	1,885	6%	—	—	—	—
OHIO	524,832	68,877	13%	41,009	8%	—	—	35,946	7%	—	—	—	—
OKLAHOMA	156,971	11,847	8%	3,216	2%	—	—	10,851	7%	4,364	3%	—	—
OREGON	131,291	—	—	—	—	—	—	—	—	—	—	—	—
PENNSYLVANIA	480,491	35,861	7%	16,946	4%	13,864	3%	—	—	—	—	—	—
RHODE ISLAND	36,882	—	—	—	—	—	—	—	—	—	—	—	—
SOUTH CAROLINA	172,465	38,650	22%	17,157	10%	11,663	7%	10,439	6%	—	—	—	—
SOUTH DAKOTA	33,366	—	—	—	—	—	—	—	—	—	—	—	—
TENNESSEE	229,539	15,769	7%	14,678	6%	2,343	1%	22,728	10%	—	—	—	—
TEXAS	885,269	52,034	6%	51,714	6%	—	—	127,201	14%	38,470	4%	17,966	2%
UTAH	111,437	—	—	—	—	—	—	—	—	—	—	—	—
VERMONT	23,656	—	—	—	—	—	—	—	—	—	—	—	—
VIRGINIA	272,940	24,871	9%	20,626	8%	—	—	26,221	10%	3,623	1%	4,114	2%
WASHINGTON	224,414	—	—	—	—	—	—	—	—	—	—	—	—
WEST VIRGINIA	96,398	9,549	10%	—	—	12,218	13%	5,308	6%	1,746	2%	432	.4%
WISCONSIN	230,394	20,519	9%	7,416	3%	—	—	29,143	13%	20,428	9%	—	—
WYOMING	26,927	784	3%	504	2%	645	2%	3,849	14%	1,001	4%	1,303	5%
TOTAL (36 states)			12%		6%		1%		7%		1%		.5%

Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina and Wisconsin, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table A-5
STUDENTS TAKING FORMAL MATHEMATICS (October 1989)
AS A PERCENT OF STUDENT IN GRADES 9–12

STATE	Total Student 9–12	Level 1 (Alg. 1)	% 9–12	Level 2 (Geom.)	% 9–12	Level 3 (Alg. 2)	% 9–12	Level 4 (Trig.)	% 9–12	Level 5 (Calc.)	% 9–12	Level 5 (Adv. Place.)	% 9–12
ALABAMA	197,613	34,289	17%	23,129	12%	21,531	11%	7,675	4%	1,208	1%	1,319	1%
ALASKA	27,582	—	—	—	—	—	—	—	—	—	—	—	—
ARIZONA	155,919	—	—	—	—	—	—	—	—	—	—	—	—
ARKANSAS	122,798	26,997	22%	16,650	—	14,458	12%	6,166	5%	1,306	1%	—	—
CALIFORNIA	1,269,871	276,017	22%	156,094	12%	133,024	10%	59,124	5%	22,720	2%	—	—
COLORADO	153,098	—	—	—	—	—	—	—	—	—	—	—	—
CONNECTICUT	123,168	19,068	15%	17,920	15%	17,689	14%	10,629	9%	2,408	2%	1,549	1%
DELAWARE	27,109	4,156	15%	3,151	12%	2,740	10%	1,967	7%	816	3%	260	1%
DIST OF COLUMBIA	18,949	3,248	17%	2,911	15%	1,862	10%	805	4%	136	1%	—	—
FLORIDA	468,910	85,002	18%	59,377	13%	48,417	10%	18,011	4%	4,136	1%	4,298	1%
GEORGIA	298,109	—	—	—	—	—	—	—	—	—	—	—	—
HAWAII	42,828	5,188	12%	3,428	8%	3,423	8%	1,773	4%	19	0%	359	1%
IDAHO	57,651	13,095	23%	10,495	18%	8,868	15%	1,924	3%	424	1%	361	1%
ILLINOIS	484,138	90,426	19%	72,852	15%	45,123	9%	32,603	7%	8,873	2%	1,072	.2%
INDIANA	275,914	44,148	16%	36,113	13%	29,885	11%	20,922	8%	5,044	2%	—	—
IOWA	132,797	31,409	24%	23,145	17%	20,354	15%	10,181	8%	3,180	2%	—	—
KANSAS	114,515	19,559	17%	14,868	13%	13,095	11%	6,513	6%	1,680	1%	723	1%
KENTUCKY	175,035	32,970	19%	25,925	15%	22,839	13%	10,253	6%	736	.4%	1,806	1%
LOUISIANA	201,564	57,643	29%	42,958	21%	30,588	15%	12,123	6%	1,222	1%	447	.2%
MAINE	60,656	12,308	20%	—	—	9,378	15%	—	—	—	—	—	—
MARYLAND	185,535	34,898	19%	30,150	16%	22,837	12%	18,806	10%	2,758	1%	2,751	1%
MASSACHUSETTS	235,350	—	—	—	—	—	—	—	—	—	—	—	—
MICHIGAN	431,833	—	—	—	—	—	—	—	—	—	—	—	—
MINNESOTA	211,046	45,071	21%	34,638	16%	28,575	14%	15,999	8%	6,278	3%	—	—
MISSISSIPPI	126,948	27,190	21%	19,492	15%	17,668	14%	10,138	8%	359	.2%	430	.3%
MISSOURI	229,868	53,154	23%	33,343	15%	31,767	14%	13,581	6%	4,249	2%	—	—
MONTANA	40,736	9,789	24%	7,500	18%	6,416	16%	2,149	5%	537	1%	15	0%
NEBRASKA	76,693	14,868	19%	12,300	16%	9,979	13%	4,126	5%	1,204	2%	—	—
NEVADA	49,357	10,648	22%	6,380	13%	3,866	8%	1,883	4%	464	1%	60	.1%
NEW HAMPSHIRE	46,964	—	—	—	—	—	—	—	—	—	—	—	—
NEW JERSEY	293,273	—	—	—	—	—	—	—	—	—	—	—	—
NEW MEXICO	76,062	21,670	28%	11,397	15%	8,509	11%	1,403	2%	888	1%	398	1%
NEW YORK	708,794	136,408	19%	102,936	15%	78,636	11%	43,011	6%	4,390	1%	14,015	2%
NORTH CAROLINA	310,919	56,849	18%	46,175	15%	37,861	12%	25,552	8%	5,406	2%	—	—
NORTH DAKOTA	32,896	8,000	24%	5,767	18%	5,200	16%	3,394	10%	210	1%	—	—
OHIO	524,832	100,402	19%	75,117	14%	58,987	11%	45,480	9%	10,224	2%	—	—
OKLAHOMA	156,971	36,020	23%	19,649	13%	23,467	15%	6,636	4%	2,974	2%	—	—
OREGON	131,291	—	—	—	—	—	—	—	—	—	—	—	—
PENNSYLVANIA	480,491	111,102	23%	71,341	15%	67,244	14%	63,464	13%	14,189	3%	4,274	1%
RHODE ISLAND	36,882	—	—	—	—	—	—	—	—	—	—	—	—
SOUTH CAROLINA	172,465	27,508	16%	23,638	14%	22,132	13%	10,163	6%	653	.3%	1,777	1%
SOUTH DAKOTA	33,366	—	—	—	—	—	—	—	—	—	—	—	—
TENNESSEE	229,539	48,800	21%	31,773	14%	29,827	13%	—	—	2,120	1%	—	—
TEXAS	885,269	202,249	23%	150,979	17%	111,541	13%	40,295	5%	9,629	1%	—	—
UTAH	111,437	—	—	—	—	—	—	—	—	—	—	—	—
VERMONT	23,656	—	—	—	—	—	—	—	—	—	—	—	—
VIRGINIA	272,940	58,615	21%	43,012	16%	35,850	13%	23,229	9%	3,493	1%	3,802	1%
WASHINGTON	224,414	—	—	—	—	—	—	—	—	—	—	—	—
WEST VIRGINIA	96,398	16,130	17%	12,611	13%	9,894	10%	4,960	5%	905	.1%	—	—
WISCONSIN	230,394	46,662	20%	28,198	12%	20,338	9%	14,154	6%	5,232	2%	—	—
WYOMING	26,927	3,686	14%	2,750	10%	1,918	7%	1,631	6%	338	1%	183	.7%
TOTAL (37 states)			21%	—	14%		12%		6%		1%		.5%

Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina and Wisconsin, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table A-6
STUDENTS TAKING BIOLOGY, CHEMISTRY, AND PHYSICS (October 1989) AS A PERCENT OF STUDENTS IN GRADES 9–12

STATE	Total Students 9–12	Biology 1st Year	% 9–12	Chemistry 1st Year	% 9–12	Physics 1st Year	% 9–12
ALABAMA	197,613	53,059	27%	17,793	9%	9,388	5%
ALASKA	27,582	—	—	—	—	—	—
ARIZONA	155,919	—	—	—	—	—	—
ARKANSAS	122,798	34,258	28%	9,925	8%	3,680	3%
CALIFORNIA	1,269,871	308,629	24%	98,518	8%	41,844	3%
COLORADO	153,098	—	—	—	—	—	—
CONNECTICUT	123,168	30,984	25%	17,893	15%	10,494	9%
DELAWARE	27,109	7,273	27%	3,025	11%	1,166	4%
DIST OF COLUMBIA	18,949	4,086	22%	2,132	11%	518	3%
FLORIDA	468,910	127,583	27%	49,696	11%	18,677	4%
GEORGIA	298,109	—	—	—	—	—	—
HAWAII	42,828	9,570	22%	4,160	10%	2,097	5%
IDAHO	57,651	11,955	21%	3,494	6%	2,005	3%
ILLINOIS	484,138	97,849	20%	45,926	9%	21,848	5%
INDIANA	275,914	69,286	25%	28,067	10%	12,660	5%
IOWA	132,797	37,035	28%	18,329	14%	9,022	7%
KANSAS	114,515	32,127	28%	12,424	11%	4,676	4%
KENTUCKY	175,035	43,691	25%	18,835	11%	5,671	3%
LOUISIANA	201,564	48,149	24%	23,380	12%	9,179	5%
MAINE	60,656	13,774	23%	8,447	14%	—	—
MARYLAND	185,535	49,556	27%	26,565	14%	11,843	6%
MASSACHUSETTS	235,350	—	—	—	—	—	—
MICHIGAN	431,833	—	—	—	—	—	—
MINNESOTA	211,046	51,939	25%	22,689	11%	12,302	6%
MISSISSIPPI	126,948	39,288	31%	16,182	13%	4,698	4%
MISSOURI	229,868	50,981	22%	22,425	10%	8,586	4%
MONTANA	40,736	10,303	25%	4,738	12%	2,338	6%
NEBRASKA	76,693	20,978	27%	8,418	11%	4,058	5%
NEVADA	49,357	8,291	17%	3,998	8%	1,453	3%
NEW HAMPSHIRE	46,964	—	—	—	—	—	—
NEW JERSEY	293,273	—	—	—	—	—	—
NEW MEXICO	76,062	20,536	27%	5,827	8%	2,412	3%
NEW YORK	708,794	189,631	27%	97,025	14%	44,064	6%
NORTH CAROLINA	310,919	81,618	26%	34,757	11%	10,649	3%
NORTH DAKOTA	32,896	8,729	27%	4,363	13%	1,951	6%
OHIO	524,832	129,478	25%	62,007	12%	25,412	5%
OKLAHOMA	156,971	37,542	24%	14,417	9%	3,908	2%
OREGON	131,291	—	—	—	—	—	—
PENNSYLVANIA	480,491	141,829	30%	65,610	14%	33,494	7%
RHODE ISLAND	36,882	—	—	—	—	—	—
SOUTH CAROLINA	172,465	43,147	25%	20,132	12%	5,849	3%
SOUTH DAKOTA	33,366	—	—	—	—	—	—
TENNESSEE	229,539	52,876	23%	22,490	10%	5,934	3%
TEXAS	885,269	235,207	27%	81,301	9%	23,636	3%
UTAH	111,437	—	—	—	—	—	—
VERMONT	23,656	—	—	—	—	—	—
VIRGINIA	272,940	69,449	25%	36,644	13%	14,915	5%
WASHINGTON	224,414	—	—	—	—	—	—
WEST VIRGINIA	96,398	24,497	25%	9,401	10%	2,527	3%
WISCONSIN	230,394	56,566	25%	28,673	12%	13,826	6%
WYOMING	26,927	5,890	22%	2,379	9%	873	3%
TOTAL (37 states)			25%		11%		4%

Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina and Wisconsin, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table A-7
STUDENTS TAKING EARTH, GENERAL, AND PHYSICAL SCIENCE (October 1989) AS A PERCENT OF STUDENTS IN GRADES 9–12

		EARTH SCIENCE		GENERAL SCIENCE		PHYSICAL SCIENCE	
STATE	Total Students 9–12	1st Year	% 9–12	1st Year	% 9–12	1st Year	% 9–12
ALABAMA	197,613	836	.4%	7,587	4%	37,822	19%
ALASKA	27,582	—	—	—	—	—	—
ARIZONA	155,919	—	—	—	—	—	—
ARKANSAS	122,798	4,971	4%	10,539	9%	30,244	25%
CALIFORNIA	1,269,871	30,218	2%	32,405	3%	159,140	13%
COLORADO	153,098	—	—	—	—	—	—
CONNECTICUT	123,168	12,571	10%	7,976	6%	7,069	6%
DELAWARE	27,109	1,668	6%	322	1%	6,026	22%
DIST OF COLUMBIA	18,949	213	1%	4,432	23%		
FLORIDA	468,910	62,617	13%	15,794	3%	62,293	13%
GEORGIA	298,109	—	—	—	—	—	—
HAWAII	42,828	1,197	3%	2,374	6%	7,325	17%
IDAHO	57,651	5,991	10%	831	1%	3,396	6%
ILLINOIS	484,138	17,674	4%	28,036	6%	28,156	6%
INDIANA	275,914	19,770	7%	15,756	6%	23,988	9%
IOWA	132,797	13,529	10%	12,409	9%	14,174	11%
KANSAS	114,515	7,545	7%	7,495	7%	13,185	12%
KENTUCKY	175,035	2,041	1%	23,589	13%	18,614	11%
LOUISIANA	201,564	7,804	4%	13,015	6%	38,174	19%
MAINE	60,656	—	—	—	—	—	—
MARYLAND	185,535	21,254	11%	5,123	3%	8,584	5%
MASSACHUSETTS	235,350	—	—	—	—	—	—
MICHIGAN	431,833	—	—	—	—	—	—
MINNESOTA	211,046	6,736	3%	—	—	39,640	19%
MISSISSIPPI	126,948	—	—	12,559	10%	—	—
MISSOURI	229,868	6,677	3%	19,333	8%	37,214	16%
MONTANA	40,736	4,734	12%	1,049	3%	3,222	8%
NEBRASKA	76,693	5,960	8%	4,892	6%	6,878	9%
NEVADA	49,357	4,231	9%	1,656	3%	772	2%
NEW HAMPSHIRE	46,964	—	—	—	—	—	—
NEW JERSEY	293,273	—	—	—	—	—	—
NEW MEXICO	76,062	1,524	2%	6,808	9%	11,039	15%
NEW YORK	708,794	118,886	17%	38,493	5%	25,451	4%
NORTH CAROLINA	310,919	6,061	2%	29	0%	77,694	25%
NORTH DAKOTA	32,896	26	0%	—	—	9,100	28%
OHIO	524,832	25,476	5%	67,354	13%	37,745	7%
OKLAHOMA	156,971	2,205	1%	6,901	4%	26,766	17%
OREGON	131,291	—	—	—	—	—	—
PENNSYLVANIA	480,491	27,659	6%	41,369	9%	29,654	6%
RHODE ISLAND	36,882	—	—	—	—	—	—
SOUTH CAROLINA	172,465	—	—	12,074	7%	35,407	21%
SOUTH DAKOTA	33,366	—	—	—	—	—	—
TENNESSEE	229,539	2,073	1%	33,006	14%	31,001	14%
TEXAS	885,269	—	—	—	—	209,223	24%
UTAH	111,437	—	—	—	—	—	—
VERMONT	23,656	—	—	—	—	—	—
VIRGINIA	272,940	64,811	24%	—	—	2,983	1%
WASHINGTON	224,414	—	—	—	—	—	—
WEST VIRGINIA	96,398	2,024	2%	6,969	7%	17,267	18%
WISCONSIN	230,394	12,628	5%	14,995	7%	27,810	12%
WYOMING	26,927	3,158	12%	1,305	5%	1,741	6%
TOTAL (36 states)			6%		5%		12%

Source: State Departments of Education, Data on Public Schools, Fall 1989; N. Carolina and Wisconsin, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table A-8
STUDENTS TAKING COMPUTER SCIENCE (October 1989) AS A PERCENT OF STUDENTS IN GRADES 9–12

STATE	Total Students 9–12	Comp. Sci./ Programming 1	% 9–1	Advanced Comp. Sci./Programming	% 9–12	Comp. Sci. Advanced Placement	% 9–12
ALABAMA	197,613	—	-	—	—	—	—
ALASKA	27,582	—	-	—	—	—	—
ARIZONA	155,919	—	-	—	—	—	—
ARKANSAS	122,798	6,641	5%	—	—	—	—
CALIFORNIA	1,269,871	20,730	2%	—	—	—	—
COLORADO	153,098	—	—	—	—	—	—
CONNECTICUT	123,168	3,416	3%	539	.4%	130	.1%
DELAWARE	27,109	2,663	10%	314	1%	8	0%
DIST OF COLUMBIA	18,949	1,523	8%	195	1%	18	0%
FLORIDA	468,910	12,079	3%	2,040	.4%	48	0%
GEORGIA	298,109	—	—	—	—	—	—
HAWAII	42,828	239	1%	3	0%	39	.1%
IDAHO	57,651	6,703	12%	269	.4%	—	—
ILLINOIS	484,138	6,711	1%	443	0%	—	—
INDIANA	275,914	7,413	3%	1,151	.4%	—	—
IOWA	132,797	1,713	1%	3,212	2%	—	—
KANSAS	114,515	17,065	15%	—	—	—	—
KENTUCKY	175,035	3,723	2%	609	.3%	113	.1%
LOUISIANA	201,564	4,986	2%	747	.3%	62	0%
MAINE	60,656	—	—	—	—	—	—
MARYLAND	185,535	8,667	5%	2,005	1%	299	.1%
MASSACHUSETTS	235,350	—	—	—	—	—	—
MICHIGAN	431,833	—	—	—	—	—	—
MINNESOTA	211,046	6,550	3%	—	—	—	—
MISSISSIPPI	126,948	4,213	3%	530	.4%	0	0%
MISSOURI	229,868	18,107	8%	4,218	2%	0	0%
MONTANA	40,736	3,946	10%	320	1%	0	0%
NEBRASKA	76,693	4,245	6%	443	1%	—	—
NEVADA	49,357	1,472	3%	248	1%	36	0%
NEW HAMPSHIRE	46,964	—	—	—	—	—	—
NEW JERSEY	293,273	—	—	—	—	—	—
NEW MEXICO	76,062	5,481	7%	294	.3%	0	0%
NEW YORK	708,794	99,062	14%	—	—	2,319	.3%
NORTH CAROLINA	310,919	11,202	4%	1,080	.3%	—	—
NORTH DAKOTA	32,896	2,483	8%	402	1%	—	—
OHIO	524,832	36,310	7%	—	—	—	—
OKLAHOMA	156,971	6,688	4%	1,504	1%	—	—
OREGON	131,291	—	—	—	—	—	—
PENNSYLVANIA	480,491	40,670	8%	9,372	2%	—	—
RHODE ISLAND	36,882	—	—	—	—	—	—
SOUTH CAROLINA	172,465	4,917	3%	88	0%	532	.3%
SOUTH DAKOTA	33,366	—	—	—	—	—	—
TENNESSEE	229,539	1,064	.4%	11	0%	83	0%
TEXAS	885,269	35,005	4%	1,321	.1%	20	0%
UTAH	111,437	—	—	—	—	—	—
VERMONT	23,656	—	—	—	—	—	—
VIRGINIA	272,940	5,589	2%	—	—	1,098	.4%
WASHINGTON	224,414	—	—	—	—	—	—
WEST VIRGINIA	96,398	7,344	8%	—	—	—	—
WISCONSIN	230,394	13,517	6%	6,058	3%	—	—
WYOMING	26,927	—	—	—	—	—	—
TOTAL (37 states)			5%		.4%		<.1%

Source: State Departments of Educa[illegible] Data on Public Schools, Fall 1989; N.Carolina and Wisconsin, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table A-9
PERCENT OF STUDENTS TAKING FIRST-YEAR BIOLOGY, CHEMISTRY, AND PHYSICS IN GENERAL VS. APPLIED COURSES (October 1989)

	BIOLOGY—1st YEAR			CHEMISTRY—1st YEAR			PHYSICS—1st YEAR		
STATE	Total	General	Basic/ Applied	Total	General	Basic/ Applied	Total	General	Basic/ Applied
ALABAMA	53,059	71%	29%	17,793	98%	2%	9,388	62%	38%
ALASKA	—	—	—	—	—	—	—	—	—
ARIZONA	—	—	—	—	—	—	—	—	—
ARKANSAS	34,258	—	—	9,925	—	—	3,680	—	—
CALIFORNIA	328,663	68	32	100,365	—	—	42,057	—	—
COLORADO	—	—	—	—	—	—	—	—	—
CONNECTICUT	30,984	59	41	17,893	76	24	10,494	63	37
DELAWARE	7,273	59	41	3,025	86	14	1,166	98	2
DIST OF COLUMBIA	4,086	99	1	2,132	99	1	518	95	5
FLORIDA	127,583	81	19	49,696	94	6	18,677	99	1
GEORGIA	—	—	—	—	—	—	—	—	—
HAWAII	9,570	57	43	4,160	63	38	2,097	61	39
IDAHO	11,955	—	—	3,494	—	—	2,005	—	—
ILLINOIS	97,849	92	8	45,926	99	1	21,848	99	1
INDIANA	69,286	79	21	28,067	98	2	12,660	96	4
IOWA	37,035	97	3	18,329	—	—	9,022	—	—
KANSAS	32,127	—	—	12,424	—	—	4,676	—	—
KENTUCKY	43,691	—	—	18,835	—	—	5,671	97	3
LOUISIANA	48,149	—	—	23,380	—	—	9,179	—	—
MAINE	13,774	—	—	8,447	—	—	—	—	—
MARYLAND	49,556	94	6	26,565	92	8	11,843	97	3
MASSACHUSETTS	—	—	—	—	—	—	—	—	—
MICHIGAN	—	—	—	—	—	—	—	—	—
MINNESOTA	51,939	96	4	22,689	—	—	12,302	—	—
MISSISSIPPI	39,288	82	18	16,182	—	—	4,698	—	—
MISSOURI	50,981	—	—	22,425	—	—	8,586	—	—
MONTANA	10,303	98	2	4,738	—	—	2,338	97	3
NEBRASKA	20,978	78	22	8,418	—	—	4,058	99	1
NEVADA	8,291	96	4	3,998	97	3	1,453	82	18
NEW HAMPSHIRE	—	—	—	—	—	—	—	—	—
NEW JERSEY	—	—	—	—	—	—	—	—	—
NEW MEXICO	20,536	—	—	5,827	—	—	2,412	—	—
NEW YORK	189,631	—	—	97,025	—	—	44,064	—	—
NORTH CAROLINA	81,618	—	—	63	—	—	34,694	—	—
NORTH DAKOTA	8,729	97	3	4,363	—	—	1,951	95	5
OHIO	129,478	—	—	62,007	—	—	25,412	—	—
OKLAHOMA	37,542	—	—	14,417	—	—	3,908	99	1
OREGON	—	—	—	—	—	—	—	—	—
PENNSYLVANIA	141,829	81	19	65,610	—	—	33,494	—	—
RHODE ISLAND	—	—	—	—	—	—	—	—	—
SOUTH CAROLINA	43,147	—	—	20,132	—	—	5,849	79	21
SOUTH DAKOTA	—	—	—	—	—	—	—	—	—
TENNESSEE	52,876	—	—	22,490	—	—	5,934	—	—
TEXAS	235,207	78	22	81,301	—	—	23,636	—	—
UTAH	—	—	—	—	—	—	—	—	—
VERMONT	—	—	—	—	—	—	—	—	—
VIRGINIA	69,449	89	11	36,644	90	10	14,915	99	1
WASHINGTON	—	—	—	—	—	—	—	—	—
WEST VIRGINIA	24,497	—	—	9,401	—	—	2,527	—	—
WISCONSIN	56,566	95	5	28,673	—	—	13,826	—	—
WYOMING	5,890	—	—	2,379	—	—	988	88	12
MEDIAN		82%	18%		94%	6%		96%	3%

Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina and Wisconsin, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table A-10
STUDENTS TAKING SCIENCE COURSES AS A PERCENT OF STUDENTS IN GRADES 7–8

STATE	Total Students 7–8	GENERAL SCIENCE	LIFE SCIENCE	EARTH SCIENCE	PHYSICAL SCIENCE
ALABAMA	115,086	48%	—	—	1%
ALASKA	15,611	—	—	—	—
ARIZONA	87,690	—	—	—	—
ARKANSAS	67,962	16	36%	35%	2
CALIFORNIA	680,491	47	14	5	9
COLORADO	80,753	—	—	—	—
CONNECTICUT	63,864	19	34	9	28
DELAWARE	14,371	—	45	51	—
DIST OF COLUMBIA	10,681	85	—	—	—
FLORIDA	261,119	23	33	11	23
GEORGIA	169,589	—	—	—	—
HAWAII	22,606	12	33	8	—
IDAHO	33,149	12	38	10	22
ILLINOIS	251,778	76	5	3	4
INDIANA	143,914	—	—	—	—
IOWA	67,886	—	—	—	—
KANSAS	61,994	26	33	23	14
KENTUCKY	96,197	43	28	24	0
LOUISIANA	116,454	13	23	18	—
MAINE	30,226	—	—	—	—
MARYLAND	98,072	12	39	13	25
MASSACHUSETTS	116,988	—	—	—	—
MICHIGAN	217,345	—	—	—	—
MINNESOTA	106,163	—	34	24	7
MISSISSIPPI	77,009	94	—	—	—
MISSOURI	120,400	33	32	25	5
MONTANA	22,372	75	8	3	2
NEBRASKA	39,291	10	13	7	8
NEVADA	27,176	2	23	7	15
NEW HAMPSHIRE	24,711	—	—	—	—
NEW JERSEY	149,004	—	—	—	—
NEW MEXICO	40,538	48	30	23	11
NEW YORK	355,657	15	41	15	29
NORTH CAROLINA	162,608	94	—	1	1
NORTH DAKOTA	17,574	—	51	49	.1
OHIO	263,144	34	7	15	5
OKLAHOMA	84,066	29	25	—	4
OREGON	71,947	—	—	—	—
PENNSYLVANIA	236,677	43	34	23	25
RHODE ISLAND	19,346	—	—	—	—
SOUTH CAROLINA	94,984	7	48	45	1
SOUTH DAKOTA	19,081	—	—	—	—
TENNESSEE	122,690	94	—	—	—
TEXAS	489,909	—	52	46	—
UTAH	67,015	—	—	—	—
VERMONT	13,772	—	—	—	—
VIRGINIA	143,067	—	37	—	46
WASHINGTON	117,489	—	—	—	—
WEST VIRGINIA	52,626	12	0	22	3
WISCONSIN	107,909	24	43	14	13
WYOMING	14,380	16	31	16	18
MEDIAN		26%	33%	15%	8%

Note: Percentages based on course enrollment data; science taught in self-contained classrooms not included.
Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina and Wisconsin, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table A-11
STUDENTS TAKING REGULAR, ACCELERATED MATHEMATICS, AND ALGEBRA 1 AS A PERCENT OF STUDENTS IN GRADES 7–8

STATE	Total Students Grade 7	Grade 7 Math	Math 7 Accelerated	Total Students Grade 8	Grade 8 Math	Math 8 Accelerated	Math 8 Algebra 1
ALABAMA	60,174	82%	13%	54,912	83%	5%	7%
ALASKA	8,039	—	—	7,572	—	—	—
ARIZONA	45,518	—	—	42,172	—	—	—
ARKANSAS	34,609	44	10	33,353	55	—	3
CALIFORNIA	349,524	79	4	330,967	70	3	13
COLORADO	41,056	—	—	39,697	—	—	—
CONNECTICUT	32,737	76	24	31,127	61	19	16
DELAWARE	7,437	86	15	6,934	62	9	20
DIST OF COLUMBIA	5,562	91	7	5,119	75	23	—
FLORIDA	133,356	74	19	127,763	67	15	11
GEORGIA	87,085	—	—	82,504	—	—	—
HAWAII	11,429	86	1	11,177	80	.3	6
IDAHO	16,962	63	11	16,187	46	11	12
ILLINOIS	129,195	83	6	122,583	78	1	7
INDIANA	73,685	—	—	70,229	—	—	—
IOWA	34,743	—	—	33,143	—	—	—
KANSAS	31,805	81	15	30,189	75	16	—
KENTUCKY	49,955	90	5	46,242	92	—	11
LOUISIANA	61,479	39	—	54,975	60	1	5
MAINE	15,309	—	—	14,917	—	—	—
MARYLAND	51,443	73	22	46,629	69	—	24
MASSACHUSETTS	58,134	—	—	58,141	—	—	—
MICHIGAN	111,085	—	—	106,260	—	—	—
MINNESOTA	54,333	58	—	51,830	48	—	6
MISSISSIPPI	40,990	93	10	36,019	78	—	7
MISSOURI	62,348	82	—	58,052	72	—	10
MONTANA	11,455	81	3	10,917	83	—	—
NEBRASKA	20,175	76	—	19,116	—	27	—
NEVADA	13,978	69	24	13,198	62	16	7
NEW HAMPSHIRE	12,653	—	—	12,058	—	—	—
NEW JERSEY	76,397	—	—	72,607	—	—	—
NEW MEXICO	20,770	85	14	19,768	82	8	8
NEW YORK	184,326	83	12	171,331	81	9	—
NORTH CAROLINA	83,328	80	8	79,280	82	11	—
NORTH DAKOTA	9,070	99	3	8,504	89	13	—
OHIO	134,903	82	14	128,241	87	—	9
OKLAHOMA	43,304	78	7	40,762	73	—	7
OREGON	36,694	—	—	35,253	—	—	—
PENNSYLVANIA	120,714	100	—	115,963	91	—	—
RHODE ISLAND	9,958	—	—	9,388	—	—	—
SOUTH CAROLINA	49,293	100	—	45,691	99	—	13
SOUTH DAKOTA	9,806	—	—	9,275	—	—	—
TENNESSEE	64,114	92	—	58,576	85	—	—
TEXAS	251,852	97	—	238,057	87	—	—
UTAH	34,452	—	—	32,563	—	—	—
VERMONT	7,026	—	—	6,746	—	—	—
VIRGINIA	73,027	75	—	70,040	89	—	—
WASHINGTON	60,872	—	—	56,617	—	—	—
WEST VIRGINIA	27,334	52	6	25,292	36	12	8
WISCONSIN	56,152	85	6	51,757	92	7	—
WYOMING	7,421	82	14	6,959	76	—	20
MEDIAN		82%	10%		78%	11%	8%

Note: Percentages based on course enrollment data; mathematics taught in self-contained classrooms not included.
Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina and Wisconsin, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

APPENDIX B

Tables with Characteristics of Teachers in Public Schools by State

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— Data not available from state.
Total = Sum of teachers with a given characteristic among the states reporting data.
Median = The median state percentage of teachers with a given characteristic.
All data on teachers in public schools.

Appendix Table B-1
MATHEMATICS TEACHERS (Grades 9–12) BY PRIMARY AND SECONDARY ASSIGNMENT

STATE	MATHEMATICS		
	Primary Assignment	Secondary Assignment	Total
ALABAMA	78%	22%	1,597
ALASKA	—	—	269*
ARIZONA	96%	4%	1,304
ARKANSAS	54%	46%	1,211*
CALIFORNIA	68%	32%	9,684
COLORADO	90%	10%	1,297
CONNECTICUT	95%	5%	1,453
DELAWARE	77%	23%	310*
DIST OF COLUMBIA	—	—	187*
FLORIDA	—	—	4,623*
GEORGIA	—	—	2,939*
HAWAII	58%	42%	831
IDAHO	70%	30%	649
ILLINOIS	—	—	3,745
INDIANA	—	—	2,298
IOWA	—	—	1,487
KANSAS	—	—	1,179
KENTUCKY	82%	18%	1,659
LOUISIANA	—	—	3,565
MAINE	—	—	796
MARYLAND	—	—	2,298
MASSACHUSETTS	—	—	3,513
MICHIGAN	91%	9%	3,339
MINNESOTA	72%	28%	1,811
MISSISSIPPI	90%	10%	719
MISSOURI	86%	14%	1,999
MONTANA	66%	34%	535
NEBRASKA	—	—	750*
NEVADA	76%	24%	673
NEW HAMPSHIRE	—	—	600
NEW JERSEY	—	—	4,375
NEW MEXICO	84%	16%	643
NEW YORK	73%	27%	7,853
NORTH CAROLINA	90%	10%	2,966
NORTH DAKOTA	66%	34%	471
OHIO	90%	10%	4,254
OKLAHOMA	89%	11%	1,674
OREGON	86%	14%	1,222
PENNSYLVANIA	97%	3%	5,704
RHODE ISLAND	99%	1%	422*
SOUTH CAROLINA	91%	9%	1,853
SOUTH DAKOTA	64%	36%	707
TENNESSEE	79%	21%	1,872
TEXAS	76%	24%	9,834
UTAH	69%	31%	1,114
VERMONT	—	—	270*
VIRGINIA	82%	18%	3,114
WASHINGTON	—	—	2,186*
WEST VIRGINIA	—	—	906
WISCONSIN	85%	15%	1,960
WYOMING	73%	27%	464
MEDIAN	82%	18%	
U.S. TOTAL			111,184

U.S. Total is based on state universe data plus imputation for non-reporting states (*).
Source: State Departments of Education, Data on Public Schools, Fall 1989; N. Carolina, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table B-2
BIOLOGY AND CHEMISTRY TEACHERS (Grades 9–12) BY PRIMARY AND SECONDARY ASSIGNMENT

	BIOLOGY			CHEMISTRY		
STATE	Primary Assignment	Secondary Assignment	Total	Primary Assignment	Secondary Assignment	Total
ALABAMA	61%	39%	809	35%	65%	380
ALASKA	—	—	107*	—	—	36*
ARIZONA	—	—	607*	—	—	202*
ARKANSAS	55%	45%	518	26%	74%	283
CALIFORNIA	59%	41%	3,733	53%	47%	1,308
COLORADO	—	—	597*	—	—	199*
CONNECTICUT	78%	22%	620	68%	32%	373
DELAWARE	43%	57%	129*	22%	78%	77*
DIST OF COLUMBIA	—	—	80*	—	—	40*
FLORIDA	—	—	3,832	—	—	1,096
GEORGIA	—	—	1,260*	—	—	630*
HAWAII	51%	49%	153	73%	27%	49
IDAHO	49%	51%	270	16%	84%	129
ILLINOIS	—	—	1,312	—	—	654
INDIANA	—	—	1,003	—	—	491
IOWA	38%	62%	700	20%	80%	427
KANSAS	—	—	653	—	—	370
KENTUCKY	34%	66%	689	43%	57%	345
LOUISIANA	—	—	816	—	—	442
MAINE	—	—	357	—	—	203
MARYLAND	—	—	784*	—	—	392*
MASSACHUSETTS	—	—	764	—	—	466
MICHIGAN	87%	13%	839	73%	27%	434
MINNESOTA	61%	39%	715	40%	60%	475
MISSISSIPPI	77%	23%	398	65%	35%	141
MISSOURI	65%	35%	986	40%	60%	574
MONTANA	38%	62%	236	18%	82%	154
NEBRASKA	—	—	288*	—	—	173*
NEVADA	59%	41%	213	58%	42%	69
NEW HAMPSHIRE	—	—	228	—	—	59
NEW JERSEY	64%	36%	1,397*	40%	60%	838*
NEW MEXICO	63%	37%	301	40%	60%	121
NEW YORK	65%	35%	5,180	66%	34%	1,864
NORTH CAROLINA	88%	12%	1,181	85%	15%	553
NORTH DAKOTA	26%	74%	262	11%	89%	174
OHIO	73%	27%	1,695	64%	36%	985
OKLAHOMA	63%	37%	901	30%	70%	481
OREGON	83%	17%	338	57%	43%	158
PENNSYLVANIA	90%	10%	1,755	85%	15%	1,016
RHODE ISLAND	88%	12%	176*	73%	27%	105*
SOUTH CAROLINA	71%	29%	615	63%	37%	324
SOUTH DAKOTA	39%	61%	230	20%	80%	151
TENNESSEE	69%	31%	709	60%	40%	357
TEXAS	58%	42%	3,951	50%	50%	1,562
UTAH	65%	35%	505	62%	38%	105
VERMONT	—	—	113*	—	—	68*
VIRGINIA	77%	23%	994	74%	26%	543
WASHINGTON	—	—	874*	—	—	291*
WEST VIRGINIA	—	—	386	—	—	182*
WISCONSIN	76%	24%	838	52%	48%	522
WYOMING	52%	48%	180	30%	70%	125
MEDIAN	63%	37%		52%	48%	
U.S. TOTAL			46,277			21,196

U.S. Total is based on state universe data plus imputation for non-reporting states (*).
Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina, Fall 1988.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table B-3
PHYSICS AND EARTH SCIENCE TEACHERS (Grades 9–12) BY PRIMARY AND SECONDARY ASSIGNMENT

	PHYSICS			EARTH SCIENCE		
STATE	Primary Assignment	Secondary Assignment	Total	Primary Assignment	Secondary Assignment	Total
ALABAMA	17%	83%	305	33%	67%	18
ALASKA	—	—	36*	—	—	36*
ARIZONA	—	—	202*	—	—	202*
ARKANSAS	5%	95%	220	45%	55%	91
CALIFORNIA	27%	73%	868	29%	71%	616
COLORADO	—	—	199*	—	—	199*
CONNECTICUT	52%	48%	243	57%	43%	258
DELAWARE	79%	24%	52*	25%	75%	52*
DIST OF COLUMBIA	—	—	27*	—	—	27*
FLORIDA	—	—	632	—	—	2,008
GEORGIA	—	—	420*	—	—	420*
HAWAII	41%	59%	39	25%	75%	76
IDAHO	5%	95%	104	36%	64%	105
ILLINOIS	—	—	293	—	—	185
INDIANA	—	—	368	—	—	283
IOWA	42%	58%	390	65%	35%	334
KANSAS	—	—	262	—	—	82
KENTUCKY	9%	91%	220	28%	72%	43
LOUISIANA	—	—	241	—	—	108
MAINE	—	—	173	—	—	174
MARYLAND	—	—	261*	—	—	261*
MASSACHUSETTS	—	—	269	—	—	323
MICHIGAN	49%	51%	261	—	—	—
MINNESOTA	24%	76%	366	40%	60%	122
MISSISSIPPI	26%	74%	46	—	—	1
MISSOURI	15%	85%	361	47%	53%	167
MONTANA	11%	89%	132	26%	74%	106
NEBRASKA	—	—	115*	—	—	58*
NEVADA	32%	68%	41	57%	43%	88
NEW HAMPSHIRE	—	—	32	—	—	34
NEW JERSEY	15%	85%	559*	66%	34%	559*
NEW MEXICO	17%	83%	78	15%	85%	55
NEW YORK	52%	48%	1,158	61%	39%	2,931
NORTH CAROLINA	80%	20%	331	77%	23%	171
NORTH DAKOTA	5%	95%	125	0%	100%	9
OHIO	27%	73%	751	60%	40%	394
OKLAHOMA	10%	90%	240	15%	85%	86
OREGON	40%	60%	106	—	—	—
PENNSYLVANIA	71%	29%	670	82%	18%	728
RHODE ISLAND	63%	37%	70*	14%	86%	70*
SOUTH CAROLINA	19%	81%	210	17%	83%	6
SOUTH DAKOTA	6%	94%	125	38%	62%	26
TENNESSEE	13%	87%	238	28%	72%	39
TEXAS	20%	80%	909	41%	59%	366
UTAH	35%	65%	69	50%	50%	109
VERMONT	—	—	45*	—	—	45*
VIRGINIA	43%	57%	323	79%	21%	789
WASHINGTON	—	—	291*	—	—	291*
WEST VIRGINIA	—	—	122	—	—	67
WISCONSIN	28%	72%	374	43%	57%	113
WYOMING	11%	89%	98	20%	80%	94
MEDIAN	26%	74%		40%	60%	
U.S. TOTAL			14,070			13,425

U.S. Total is based on state universe data plus imputation for non-reporting states (*).
Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina, Fall 1988.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table B-4
GENERAL, PHYSICAL, AND COMPUTER SCIENCE TEACHERS (Grades 9–12) BY PRIMARY AND SECONDARY ASSIGNMENT

	GENERAL SCIENCE			PHYSICAL SCIENCE			COMPUTER SCIENCE		
STATE	Primary Assignment	Secondary Assignment	Total	Primary Assignment	Secondary Assignment	Total	Primary Assignment	Secondary Assignment	Total
ALABAMA	36%	64%	136	41%	59%	611	32%	68%	107
ALASKA	—	—	—	—	—	—	—	—	—
ARIZONA	—	—	—	—	—	—	85%	15%	78
ARKANSAS	35%	65%	210	48%	52%	485	34%	66%	181
CALIFORNIA	30%	70%	540	39%	61%	2,155	29%	71%	1,252
COLORADO	—	—	—	—	—	—	—	—	—
CONNECTICUT	55%	45%	311	41%	59%	179	25%	75%	253
DELAWARE	—	—	19	—	—	—	—	—	—
DIST OF COLUMBIA	—	—	—	—	—	—	—	—	—
FLORIDA	—	—	634	—	—	1,914	—	—	746
GEORGIA	—	—	—	—	—	—	—	—	—
HAWAII	18%	82%	130	37%	63%	137	16%	84%	25
IDAHO	26%	74%	176	17%	83%	109	11%	89%	123
ILLINOIS	89%	11%	489	96%	4%	198	63%	37%	520
INDIANA	—	—	437	—	—	338	—	—	211
IOWA	86%	14%	368	99%	1%	297	—	—	144
KANSAS	—	—	443	—	—	141	—	—	301
KENTUCKY	42%	58%	406	39%	61%	329	20%	80%	148
LOUISIANA	—	—	218	—	—	597	—	—	172
MAINE	—	—	120	—	—	167	—	—	171
MARYLAND	—	—	—	—	—	—	—	—	—
MASSACHUSETTS	—	—	1,322	—	—	—	—	—	—
MICHIGAN	80%	20%	1,578	—	—	—	55%	45%	274
MINNESOTA	—	—	—	45%	55%	618	17%	86%	235
MISSISSIPPI	40%	60%	85	—	—	—	37%	63%	35
MISSOURI	30%	70%	420	44%	56%	635	43%	57%	482
MONTANA	13%	87%	39	18%	82%	84	10%	90%	220
NEBRASKA	—	—	—	—	—	—	—	—	—
NEVADA	52%	48%	159	—	—	—	43%	57%	155
NEW HAMPSHIRE	—	—	186	—	—	10	—	—	—
NEW JERSEY	—	—	522	—	—	734	—	—	618
NEW MEXICO	30%	70%	106	44%	56%	162	38%	62%	129
NEW YORK	50%	50%	1,591	54%	46%	2,160	21%	79%	1,065
NORTH CAROLINA	—	—	—	84%	16%	1,102	48%	52%	282
NORTH DAKOTA	—	—	—	18%	82%	264	4%	96%	141
OHIO	51%	49%	1,002	50%	50%	590	48%	52%	627
OKLAHOMA	28%	72%	243	48%	52%	530	32%	68%	331
OREGON	84%	21%	525	—	—	—	42%	58%	137
PENNSYLVANIA	—	—	—	—	—	—	—	—	—
RHODE ISLAND	—	—	135	—	—	18	—	—	47
SOUTH CAROLINA	34%	66%	253	54%	46%	541	43%	57%	119
SOUTH DAKOTA	21%	79%	34	21%	79%	172	31%	69%	259
TENNESSEE	47%	53%	530	56%	44%	412	21%	79%	47
TEXAS	—	—	—	50%	50%	3,461	47%	53%	1,839
UTAH	—	—	—	67%	33%	133	43%	57%	120
VERMONT	—	—	—	—	—	—	—	—	—
VIRGINIA	—	—	—	28%	72%	76	30%	70%	227
WASHINGTON	—	—	—	—	—	—	—	—	—
WEST VIRGINIA	—	—	128	—	—	281	—	—	177
WISCONSIN	51%	49%	406	33%	67%	233	15%	85%	396
WYOMING	52%	48%	264	—	—	—	—	—	—
MEDIAN	40%	60%		44%	56%		32%	68%	
TOTAL (36 states)			14,165			19,873			12,394

Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina, Fall 1988.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table B-5
SCIENCE TEACHERS (Grades 9-12)
(Population Estimates)

STATE	SCIENCE (All Fields) Total
ALABAMA	2,486
ALASKA	440
ARIZONA	1,030
ARKANSAS	1,536
CALIFORNIA	8,529
COLORADO	1,277
CONNECTICUT	1,998
DELAWARE	152
DIST OF COLUMBIA	111
FLORIDA	3,183
GEORGIA	2,923
HAWAII	239
IDAHO	549
ILLINOIS	3,791
INDIANA	2,084
IOWA	1,423
KANSAS	1,358
KENTUCKY	1,695
LOUISIANA	1,995
MAINE	673
MARYLAND	1,253
MASSACHUSETTS	2,664
MICHIGAN	4,044
MINNESOTA	1,955
MISSISSIPPI	777
MISSOURI	1,934
MONTANA	824
NEBRASKA	828
NEVADA	388
NEW HAMPSHIRE	343
NEW JERSEY	3,201
NEW MEXICO	622
NEW YORK	7,576
NORTH CAROLINA	2,698
NORTH DAKOTA	595
OHIO	3,992
OKLAHOMA	2,482
OREGON	1,171
PENNSYLVANIA	5,195
RHODE ISLAND	201
SOUTH CAROLINA	1,037
SOUTH DAKOTA	392
TENNESSEE	1,817
TEXAS	8,192
UTAH	1,002
VERMONT	318
VIRGINIA	2,474
WASHINGTON	2,678
WEST VIRGINIA	810
WISCONSIN	2,549
WYOMING	383
U.S. TOTAL	101,867

Note: The number of science teachers per state is a population estimate based on a state-representative sample of teachers responding to the Schools and Staffing Survey.

Source: National Center for Education Statistics, 1988.

Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table B-6
AGE OF SCIENCE AND MATHEMATICS TEACHERS (Grades 9–12)

	MATH				BIOLOGY				CHEMISTRY				PHYSICS			
STATE	Total Teachers	Under 30	Age 30–49	Over 50	Total Teachers	Under 30	Age 30–49	Over 50	Total Teachers	Under 30	Age 30–49	Over 50	Total Teachers	Under 30	Age 30–49	Over 50
ALABAMA	1,597	13%	69%	13%	809	12%	72%	12%	380	14%	66%	15%	305	16%	60%	18%
ALASKA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ARIZONA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
ARKANSAS	(P)650	14%	71%	15%	518	12%	74%	14%	283	12%	71%	18%	220	13%	65%	22%
CALIFORNIA	9,684	13%	61%	26%	3,733	14%	65%	21%	1,308	15%	62%	23%	868	14%	63%	22%
COLORADO	1,297	9%	69%	22%	(*)1,161	9%	69%	22%	—	—	—	—	—	—	—	—
CONNECTICUT	1,453	6%	74%	20%	620	6%	70%	24%	373	6%	67%	27%	243	7%	64%	29%
DELAWARE	(P)240	9%	63%	28%	(P)55	4%	73%	23%	(P)17	0%	59%	41%	(P)41	17%	54%	29%
DIST OF COLUMBIA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
FLORIDA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
GEORGIA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
HAWAII	831	14%	63%	17%	153	14%	62%	15%	49	12%	67%	18%	39	15%	62%	21%
IDAHO	649	17%	64%	19%	270	8%	73%	20%	129	11%	62%	27%	104	13%	56%	31%
ILLINOIS	3,745	11%	66%	23%	1,312	9%	63%	28%	654	10%	60%	30%	293	12%	56%	32%
INDIANA	2,298	15%	68%	17%	1,003	11%	67%	22%	491	13%	66%	21%	368	13%	62%	25%
IOWA	1,487	15%	67%	18%	700	16%	65%	19%	427	17%	63%	20%	390	16%	63%	21%
KANSAS	1,179	22%	57%	21%	653	16%	64%	20%	370	20%	63%	17%	262	14%	63%	23%
KENTUCKY	1,659	19%	71%	10%	689	11%	75%	14%	345	14%	73%	13%	220	16%	71%	12%
LOUISIANA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MAINE	796	14%	71%	15%	357	16%	69%	15%	203	14%	68%	18%	173	13%	83%	21%
MARYLAND	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MASSACHUSETTS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
MICHIGAN	3,339	8%	68%	24%	839	8%	66%	26%	434	5%	62%	33%	261	6%	66%	29%
MINNESOTA	1,811	10%	61%	29%	715	9%	61%	30%	475	9%	92%	45%	366	8%	59%	33%
MISSISSIPPI	719	14%	68%	17%	398	11%	71%	18%	141	13%	68%	18%	46	9%	70%	20%
MISSOURI	1,999	19%	65%	15%	986	17%	68%	14%	574	19%	63%	18%	361	14%	65%	21%
MONTANA	535	13%	68%	19%	236	12%	70%	18%	154	18%	65%	17%	132	16%	67%	17%
NEBRASKA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	
NEVADA	673	11%	68%	22%	213	10%	71%	19%	69	13%	77%	10%	41	7%	73%	20%
NEW HAMPSHIRE	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
NEW JERSEY	(P)4,375	10%	71%	19%	(P)887	10%	71%	20%	(P)337	12%	66%	22%	(P)82	7%	65%	28%
NEW MEXICO	643	12%	68%	20%	301	13%	69%	18%	121	7%	75%	18%	78	10%	73%	17%
NEW YORK	7,853	9%	71%	20%	5,180	11%	68%	21%	1,864	9%	64%	27%	1,158	7%	66%	27%
NORTH CAROLINA	(P)2,656	20%	70%	10%	(P)1,036	21%	66%	13%	(P)469	46%	25%	29%	(P)264	15%	68%	17%
NORTH DAKOTA	471	22%	65%	[illegible]	262	19%	65%	16%	174	20%	67%	13%	125	14%	70%	16%
OHIO	4,254	16%	70%	13%	1,695	12%	73%	16%	985	14%	71%	15%	751	13%	73%	14%
OKLAHOMA	1,674	17%	72%	11%	901	19%	72%	F9%	481	14%	73%	13%	240	7%	75%	18%
OREGON	1,222	12%	65%	22%	338	9%	69%	22%	—	—	—	—	—	—	—	—
PENNSYLVANIA	5,704	9%	72%	19%	1,755	8%	70%	22%	1,016	10%	66%	24%	670	10%	64%	26%
RHODE ISLAND	(P)418	3%	82%	15%	(P)155	6%	77%	17%	(P)77	3%	68%	30%	(P)44	2%	80%	18%
SOUTH CAROLINA	1,853	18%	70%	13%	615	15%	72%	13%	324	15%	68%	17%	210	13%	70%	17%
SOUTH DAKOTA	707	18%	60%	22%	230	23%	64%	13%	151	23%	60%	17%	125	22%	60%	18%
TENNESSEE	1,872	15%	63%	14%	709	12%	66%	13%	357	13%	64%	18%	238	9%	63%	21%
TEXAS	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
UTAH	1,114	16%	62%	22%	505	12%	68%	20%	105	11%	72%	17%	69	10%	71%	19%
VERMONT	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
VIRGINIA	3,114	12%	69%	19%	994	12%	66%	22%	543	13%	64%	24%	323	13%	56%	31%
WASHINGTON	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
WEST VIRGINIA	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
WISCONSIN	1,960	13%	66%	21%	838	8%	65%	27%	522	10%	62%	28%	374	9%	60%	30%
WYOMING	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
TOTAL (36 states)		13%	68%	19%		12%	68%	20%		13%	65%	22%		11%	65%	23%

Note: Total Teachers=Teachers with primary or secondary assignment in subject;
*Total Teachers reported under Biology = All science fields
Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina, Fall 1988.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table B-7
GENDER OF SCIENCE AND MATHEMATICS TEACHERS (Grades 9–12)

	MATH			BIOLOGY			CHEMISTRY			PHYSICS		
STATE	Total Teachers	Male	Female	Total Teachers	Male	Female	Total Teachers	Male	Female	Total Teachers	Male	Female
ALABAMA	1,597	36%	64%	809	37%	63%	380	40%	60%	305	51%	49%
ALASKA	—	—	—	—	—	—	—	—	—	—	—	—
ARIZONA	1,304	57%	43%	(*) 1,093	66%	34%	—	—	—	—	—	—
ARKANSAS	(P) 650	39%	61%	518	51%	49%	283	60%	40%	220	66%	34%
CALIFORNIA	9,684	66%	34%	3,733	68%	32%	1,308	71%	29%	868	82%	18%
COLORADO	1,297	63%	37%	(*) 1,161	72%	28%	—	—	—	—	—	—
CONNECTICUT	1,453	54%	46%	620	62%	38%	373	68%	32%	243	82%	18%
DELAWARE	(P) 240	54%	46%	(P) 55	62%	38%	(P) 17	71%	29%	(P) 41	66%	34%
DIST OF COLUMBIA	—	—	—	—	—	—	—	—	—	—	—	—
FLORIDA	—	—	—	—	—	—	—	—	—	—	—	—
GEORGIA	—	—	—	—	—	—	—	—	—	—	—	—
HAWAII	831	41%	54%	153	47%	44%	49	43%	55%	39	69%	28%
IDAHO	649	69%	31%	270	81%	19%	129	78%	22%	104	83%	17%
ILLINOIS	3,745	58%	42%	1,312	66%	34%	654	70%	30%	293	87%	13%
INDIANA	2,298	62%	38%	1,003	74%	26%	491	71%	29%	368	85%	15%
IOWA	1,487	72%	28%	700	79%	21%	427	78%	22%	390	80%	20%
KANSAS	1,179	66%	34%	653	73%	26%	370	75%	25%	262	85%	17%
KENTUCKY	1,659	41%	59%	689	53%	47%	345	55%	45%	220	73%	27%
LOUISIANA	—	—	—	—	—	—	—	—	—	—	—	—
MAINE	796	66%	34%	357	68%	32%	203	76%	24%	173	88%	12%
MARYLAND	2,298	43%	57%	(*) 2,050	54%	46%	—	—	—	—	—	—
MASSACHUSETTS	—	—	—	—	—	—	—	—	—	—	—	—
MICHIGAN	3,339	66%	34%	839	77%	23%	434	80%	20%	261	90%	10%
MINNESOTA	1,811	79%	21%	715	81%	19%	475	83%	17%	366	90%	10%
MISSISSIPPI	719	34%	65%	398	45%	54%	141	46%	53%	46	52%	46%
MISSOURI	1,999	49%	51%	986	60%	40%	574	59%	41%	361	73%	27%
MONTANA	535	72%	28%	236	84%	16%	154	85%	15%	132	89%	11%
NEBRASKA	—	—	—	—	—	—	—	—	—	—	—	—
NEVADA	673	62%	38%	213	68%	32%	69	75%	25%	41	78%	22%
NEW HAMPSHIRE	600	48%	52%	228	56%	44%	59	68%	32%	32	84%	16%
NEW JERSEY	(P) 4,375	40%	60%	(P) 887	54%	46%	(P) 337	63%	37%	(P) 82	82%	18%
NEW MEXICO	643	58%	42%	301	68%	32%	121	67%	33%	78	76%	24%
NEW YORK	7,853	56%	44%	5,180	62%	38%	1,864	72%	28%	1,158	86%	14%
NORTH CAROLINA	(P) 2,656	31%	69%	(P) 1,036	43%	57%	(P) 469	46%	54%	(P) 264	61%	39%
NORTH DAKOTA	471	67%	33%	262	75%	25%	174	74%	26%	125	79%	20%
OHIO	4,254	60%	40%	1,695	69%	31%	985	69%	31%	751	78%	22%
OKLAHOMA	1,674	51%	49%	901	61%	39%	481	62%	38%	240	72%	29%
OREGON	1,222	74%	26%	338	79%	21%	158	—	—	106	—	—
PENNSYLVANIA	5,704	62%	38%	1,755	72%	28%	1,016	72%	28%	670	86%	14%
RHODE ISLAND	(P) 418	57%	43%	(P) 155	63%	37%	(P) 77	70%	30%	(P) 44	80%	20%
SOUTH CAROLINA	1,853	31%	69%	615	40%	60%	324	43%	57%	210	56%	44%
SOUTH DAKOTA	707	48%	52%	230	74%	26%	151	65%	35%	125	70%	30%
TENNESSEE	1,872	44%	53%	709	49%	47%	357	51%	49%	238	67%	31%
TEXAS	9,834	41%	59%	3,951	52%	48%	1,562	52%	48%	909	66%	34%
UTAH	1,114	68%	32%	505	78%	22%	105	86%	14%	69	90%	10%
VERMONT	—	—	—	—	—	—	—	—	—	—	—	—
VIRGINIA	3,114	34%	66%	994	42%	58%	543	45%	55%	323	69%	31%
WASHINGTON	—	—	—	—	—	—	—	—	—	—	—	—
WEST VIRGINIA	—	—	—	—	—	—	—	—	—	—	—	—
WISCONSIN	1,960	70%	30%	838	84%	16%	522	83%	17%	374	89%	11%
WYOMING	—	—	—	—	—	—	—	—	—	—	—	—
TOTAL (40 states)		55%	45%		63%	37%		66%	34%		78%	22%

Note: Total Teachers=Teachers with primary or secondary assignment in subject; (P) Only teachers with primary assignment reported.
*Total Teachers reported under Biology = All science fields
Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina, Fall 1988.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table B-8
RACE/ETHNICITY OF TEACHERS ASSIGNED IN MATHEMATICS AND BIOLOGY (Grades 9–12)

	MATHEMATICS TEACHERS						BIOLOGY TEACHERS					
STATE	Total Teachers	Hispanic	White	Black	Asian	Indian	Total Teachers	Hispanic	White	Black	Asian	Indian
ALABAMA	1,597	0%	82%	17%	0%	.2%	809	0%	81%	18%	.4%	.4%
ALASKA	—	—	—	—	—	—	—	—	—	—	—	—
ARIZONA	1,304	3%	94%	1%	1%	1%	(*) 1,093	3%	95%	1%	1%	1%
ARKANSAS	(P) 650	0%	89%	11%	0%	0%	518	.2%	90%	9%	.4%	0%
CALIFORNIA	9,684	5%	82%	5%	6%	1%	3,733	5%	84%	4%	5%	1%
COLORADO	1,297	2%	95%	1%	1%	.5%	(*) 1,161	3%	94%	1%	1%	1%
CONNECTICUT	1,453	1%	97%	2%	.5%	0%	620	1%	95%	3%	.3%	0%
DELAWARE	(P) 240	0%	93%	7%	.4%	.4%	(P) 55	0%	96%	4%	0%	0%
DIST OF COLUMBIA	—	—	—	—	—	—	—	—	—	—	—	—
FLORIDA	—	—	—	—	—	—	—	—	—	—	—	—
GEORGIA	—	-	—	—	—	—	—	—	—	—	—	—
HAWAII	831	.2%	23%	1%	71%	0%	153	0%	30%	1%	61%	0%
IDAHO	649	.3%	98%	0%	1%	.3%	270	.4%	99%	0%	0%	1%
ILLINOIS	3,745	1%	89%	9%	1%	0%	1,312	1%	88%	10%	.3%	0%
INDIANA	2,298	.1%	97%	2%	.3%	0%	1,003	0%	97%	2%	0%	0%
IOWA	1,487	0%	99%	.3%	.3%	.3%	700	0%	99%	.3%	.3%	.3%
KANSAS	1,179	.3%	92%	2%	.2%	1%	653	.2%	94%	.5%	.2%	1%
KENTUCKY	1,659	0%	98%	2%	.1%	0%	689	0%	97%	3%	.1%	.1%
LOUISIANA	—	—	—	—	—	—	—	—	—	—	—	—
MAINE	796	.1%	99%	0%	.1%	0%	357	0%	100%	0%	0%	0%
MARYLAND	2,298	0%	83%	16%	0%	1%	(*) 2,050	0%	84%	15%	0%	1%
MASSACHUSETTS	—	—	—	—	—	—	—	—	—	—	—	—
MICHIGAN	3,339	.3%	93%	7%	.4%	.2%	839	.4%	97%	2%	.4%	.2%
MINNESOTA	—	—	—	—	—	—	—	—	—	—	—	—
MISSISSIPPI	719	—	74%	26%	—	—	398	—	69%	30%	—	—
MISSOURI	—	—	—	—	—	—	—	—	—	—	—	—
MONTANA	535	.2%	99%	.2%	0%	.4%	236	0%	99%	.4%	0%	.4%
NEBRASKA	—	—	—	—	—	—	—	—	—	—	—	—
NEVADA	673	4%	91%	2%	2%	1%	213	4%	93%	2%	0%	0%
NEW HAMPSHIRE	—	—	—	—	—	—	—	—	—	—	—	—
NEW JERSEY	(P) 4,375	1%	90%	7%	1%	0%	(P) 887	1%	93%	6%	1%	0%
NEW MEXICO	643	18%	80%	.5%	1%	1%	301	17%	81%	1%	.3%	1%
NEW YORK	—	—	—	—	—	—	—	—	—	—	—	—
NORTH CAROLINA	(P) 2,656	0%	86%	13%	.2%	.8%	(P) 1,036	0%	84%	16%	.2%	.6%
NORTH DAKOTA	471	0%	99%	0%	0%	.2%	262	0%	99%	0%	.4%	.4%
OHIO	4,254	.1%	97%	3%	.3%	0%	1,695	.2%	95%	4%	.2%	0%
OKLAHOMA	1,674	0%	95%	3%	.2%	2%	901	.2%	95%	3%	.1%	2%
OREGON	—	—	—	—	—	—	—	—	—	—	—	—
PENNSYLVANIA	5,704	.1%	97%	3%	0%	0%	1,755	.2%	97%	2%	.3%	.1%
RHODE ISLAND	(P) 418	1%	97%	.2%	.2%	.5%	(P) 155	1%	97%	1%	1%	0%
SOUTH CAROLINA	1,853	0%	78%	22%	.3%	0%	615	0%	79%	21%	.2%	0%
SOUTH DAKOTA	—	—	—	—	—	—	—	—	—	—	—	—
TENNESSEE	—	—	—	—	—	—	—	—	—	—	—	—
TEXAS	9,834	9%	82%	8%	1%	.2%	3,951	9%	83%	8%	.3%	.3%
UTAH	1,114	.4%	98%	.2%	1%	.4%	505	1%	98%	.2%	1%	.4%
VERMONT	—	—	—	—	—	—	—	—	—	—	—	—
VIRGINIA	3,114	.4%	87%	12%	.4%	.3%	994	.1%	86%	13%	1%	.2%
WASHINGTON	—	—	—	—	—	—	—	—	—	—	—	—
WEST VIRGINIA	—	—	—	—	—	—	—	—	—	—	—	—
WISCONSIN	1,960	.2%	98%	1%	.3%	0%	836	.4%	98%	1%	.4%	.2%
WYOMING	—	—	—	—	—	—	—	—	—	—	—	—
TOTAL (33 states)		2%	89%	6%	2%	.3%		2%	90%	6%	1%	.4%

(P) = Only teachers with primary assignment reported.
*Total Teachers reported under Biology = All science fields
Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table B-9
RACE/ETHNICITY OF TEACHERS ASSIGNED IN CHEMISTRY AND PHYSICS (Grades 9–12)

	CHEMISTRY TEACHERS						PHYSICS TEACHERS					
STATE	Total Teachers	Hispanic	White	Black	Asian	Indian	Total Teachers	Hispanic	White	Black	Asian	Indian
ALABAMA	380	0%	83%	16%	0%	1%	305	0%	86%	14%	0%	1%
ALASKA	—	—	—	—	—	—	—	—	—	—	—	—
ARIZONA	—	—	—	—	—	—	—	—	—	—	—	—
ARKANSAS	283	0%	94%	6%	0%	0%	220	0%	96%	4%	0%	0%
CALIFORNIA	1,308	4%	88%	3%	5%	1%	868	2%	91%	2%	4%	1%
COLORADO	—	—	—	—	—	—	—	—	—	—	—	—
CONNECTICUT	373	1%	98%	1%	.3%	0%	243	.4%	98%	1%	1%	0%
DELAWARE	(P) 17	0%	100%	0%	0%	0%	(P) 41	0%	90%	10%	0%	0%
DIST OF COLUMBIA	—	—	—	—	—	—	—	—	—	—	—	—
FLORIDA	—	—	—	—	—	—	—	—	—	—	—	—
GEORGIA	—	—	—	—	—	—	—	—	—	—	—	—
HAWAII	49	0%	33%	0%	65%	0%	39	0%	38%	0%	59%	0%
IDAHO	129	0%	100%	0%	0%	0%	104	1%	99%	0%	0%	0%
ILLINOIS	654	1%	93%	6%	.5%	0%	293	.3%	96%	3%	1%	0%
INDIANA	491	.4%	98%	1%	1%	.4%	368	0%	99%	0%	.3%	0%
IOWA	427	0%	99%	.5%	.5%	0%	390	0%	99%	1%	0%	0%
KANSAS	370	1%	94%	1%	1%	1%	262	1%	97%	1%	0%	1%
KENTUCKY	345	0%	99%	1%	.3%	0%	220	0%	99%	.5%	.5%	0%
LOUISIANA	—	—	—	—	—	—	—	—	—	—	—	—
MAINE	203	0%	99%	0%	0%	0%	173	0%	98%	0%	0%	0%
MARYLAND	—	—	—	—	—	—	—	—	—	—	—	—
MASSACHUSETTS	—	—	—	—	—	—	—	—	—	—	—	—
MICHIGAN	434	0%	99%	.5%	.2%	0%	261	0%	99%	1%	0%	0%
MINNESOTA	—	—	—	—	—	—	—	—	—	—	—	—
MISSISSIPPI	141	—	73%	26%	—	—	46	—	74%	24%	—	—
MISSOURI	—	—	—	—	—	—	—	—	—	—	—	—
MONTANA	154	0%	100%	0%	0%	0%	132	0%	100%	0%	0%	0%
NEBRASKA	—	—	—	—	—	—	—	—	—	—	—	—
NEVADA	69	0%	97%	0%	3%	0%	41	0%	98%	0%	0%	0%
NEW HAMPSHIRE	—	—	—	—	—	—	—	—	—	—	—	—
NEW JERSEY	(P) 337	0%	95%	4%	1%	0%	(P) 82	0%	96%	2%	1%	0%
NEW MEXICO	121	17%	81%	0%	2%	1%	78	13%	85%	1%	0%	1%
NEW YORK	—	—	—	—	—	—	—	—	—	—	—	—
NORTH CAROLINA	(P) 469	0%	89%	10%	.4%	1%	(P) 264	0%	94%	5%	.4%	.8%
NORTH DAKOTA	174	0%	99%	0%	1%	0%	125	0%	100%	0%	0%	0%
OHIO	985	0%	98%	2%	.3%	0%	751	0%	99%	1%	.1%	0%
OKLAHOMA	481	1%	96%	1%	.2%	2%	240	.4%	98%	0%	0%	1%
OREGON	—	—	—	—	—	—	—	—	—	—	—	—
PENNSYLVANIA	1,016	0%	99%	1%	0%	0%	670	0%	99%	.3%	.1%	0%
RHODE ISLAND	(P) 77	0%	95%	1%	0%	0%	(P) 44	0%	100%	0%	0%	0%
SOUTH CAROLINA	324	0%	83%	17%	.3%	0%	210	0%	85%	13%	1%	.5%
SOUTH DAKOTA	—	—	—	—	—	—	—	—	—	—	—	—
TENNESSEE	—	—	—	—	—	—	—	—	—	—	—	—
TEXAS	1,562	7%	89%	4%	.4%	.1%	909	5%	93%	2%	1%	.1%
UTAH	105	0%	99%	0%	1%	0%	69	1%	99%	0%	0%	0%
VERMONT	—	—	—	—	—	—	—	—	—	—	—	—
VIRGINIA	543	.2%	90%	9%	1%	.4%	323	1%	91%	8%	1%	0%
WASHINGTON	—	—	—	—	—	—	—	—	—	—	—	—
WEST VIRGINIA	—	—	—	—	—	—	—	—	—	—	—	—
WISCONSIN	522	0%	99%	1%	1%	0%	374	0%	99%	.3%	1%	0%
WYOMING	—	—	—	—	—	—	—	—	—	—	—	—
TOTAL (33 states)		2%	93%	3%	1%	.3%		1%	95%	2%	1%	.2%

(P) Only teachers with primary assignment reported.
Source: State Departments of Education, Data on Public Schools, Fall 1989; N.Carolina, Fall 1988.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table B-10
ALL TEACHERS IN STATE IN GRADES 9–12 BY AGE, GENDER, AND RACE/ETHNICITY

STATE	Total	Under 30	Age 30–49	Over 50	Male	Female	Hispanic	White	Black	Asian	Indian
ALABAMA	13,453	8%	69%	18%	40%	60%	.2%	79%	20%	0%	.1%
ALASKA	—	—	—	—	—	—	—	—	—	—	—
ARIZONA	10,980	—	—	—	49%	51%	7%	90%	2%	1%	1%
ARKANSAS	17,925	13%	71%	16%	39%	61%	.2%	90%	10%	0%	0%
CALIFORNIA	56,566	10%	63%	26%	57%	43%	7%	82%	5%	4%	1%
COLORADO	8,744	7%	70%	23%	56%	44%	4%	93%	2%	.5%	.5%
CONNECTICUT	13,008	5%	71%	24%	50%	50%	1%	95%	3%	.2%	0%
DELAWARE	2,248	6%	66%	28%	52%	48%	.4%	89%	10%	.3%	.1%
DIST OF COLUMBIA	—	—	—	—	—	—	—	—	—	—	—
FLORIDA	23,008	—	—	—	45%	55%	3%	85%	11%	.2%	0%
GEORGIA	—	—	—	—	—	—	—	—	—	—	—
HAWAII	3,656	10%	68%	22%	40%	60%	.2%	22%	1%	77%	0%
IDAHO	4,315	11%	70%	19%	55%	45%	1%	98%	.1%	1%	.3%
ILLINOIS	29,523	8%	65%	27%	55%	45%	1%	88%	10%	.4%	0%
INDIANA	19,167	10%	69%	20%	52%	48%	.4%	96%	3%	.2%	0%
IOWA	11,029	15%	68%	17%	62%	38%	.4%	99%	.4%	.1%	.1%
KANSAS	10,814	14%	64%	22%	54%	45%	1%	91%	2%	.2%	1%
KENTUCKY	12,078	12%	73%	15%	42%	58%	0%	96%	3%	.1%	0%
LOUISIANA	—	—	—	—	—	—	—	—	—	—	—
MAINE	6,317	14%	70%	16%	56%	44%	.3%	99%	0%	0%	0%
MARYLAND	—	—	—	—	—	—	—	—	—	—	—
MASSACHUSETTS	—	—	—	—	—	—	—	—	—	—	—
MICHIGAN	24,981	6%	69%	26%	55%	45%	.4%	92%	7%	.3%	.2%
MINNESOTA	16,012	8%	67%	25%	59%	41%	—	—	—	—	—
MISSISSIPPI	7,291	11%	72%	18%	36%	64%	—	69%	31%	—	—
MISSOURI	20,950	16%	67%	17%	47%	53%	—	—	—	—	—
MONTANA	3,525	10%	73%	17%	60%	40%	.2%	98%	.2%	.1%	1%
NEBRASKA	6,419	—	—	—	55%	45%	1%	98%	1%	.1%	0%
NEVADA	3,512	8%	70%	22%	51%	49%	5%	90%	3%	1%	1%
NEW HAMPSHIRE	3,503	—	—	—	48%	52%	—	—	—	—	—
NEW JERSEY	30,718	12%	68%	20%	46%	54%	2%	90%	8%	.5%	0%
NEW MEXICO	3,884	10%	71%	19%	53%	47%	23%	75%	1%	0%	1%
NEW YORK	63,000	9%	67%	24%	51%	49%	2%	93%	5%	1%	0%
NORTH CAROLINA	19,598	14%	72%	14%	40%	60%	0%	84%	15%	0%	1%
NORTH DAKOTA	3,115	15%	70%	15%	54%	46%	.2%	98%	0%	0%	1%
OHIO	34,318	11%	73%	16%	53%	47%	.4%	94%	5%	.2%	0%
OKLAHOMA	13,391	14%	74%	12%	46%	54%	.4%	94%	4%	.2%	2%
OREGON	9,877	8%	71%	22%	56%	44%	—	—	—	—	—
PENNSYLVANIA	41,025	6%	68%	27%	58%	42%	.3%	97%	3%	0%	0%
RHODE ISLAND	4,494	3%	73%	24%	53%	47%	.3%	94%	1%	.2%	.3%
SOUTH CAROLINA	11,625	14%	70%	16%	36%	64%	.3%	80%	20%	.1%	0%
SOUTH DAKOTA	3,335	19%	65%	16%	54%	46%	—	—	—	—	—
TENNESSEE	12,318	10%	71%	18%	44%	52%	—	—	—	—	—
TEXAS	71,858	—	—	—	41%	59%	11%	81%	8%	.2%	.2%
UTAH	6,643	12%	65%	24%	55%	45%	1%	97%	.2%	1%	.5%
VERMONT	—	—	—	—	—	—	—	—	—	—	—
VIRGINIA	21,135	10%	69%	21%	38%	62%	1%	85%	14%	.3%	0%
WASHINGTON	—	—	—	—	—	—	—	—	—	—	—
WEST VIRGINIA	—	—	—	—	—	—	—	—	—	—	—
WISCONSIN	15,649	9%	69%	22%	58%	42%	.3%	98%	2%	.2%	.1%
WYOMING	2,881	—	—	—	56%	44%	—	—	—	—	—
TOTAL (42 states)		10%	69%	21%	50%	50%	.3%	89%	6%	1%	<1%

Source: State Departments of Education, Data on Public Schools, Fall 1989; North Carolina, Fall 1988.
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table B-11
STATE CERTIFICATION REQUIREMENTS FOR SECONDARY SCIENCE AND MATHEMATICS TEACHERS

STATE	Course Credits by Certification Field: MATH	Course Credits by Certification Field: SCIENCE, BROAD FIELD	Course Credits by Certification Field: BIOLOGY, CHEMISTRY, PHYSICS	Teaching Methods Req. Science/Math	Superv. Teaching Experience Required
ALABAMA	27	52	27	Yes	9
ALASKA	*	*	*	*	*
ARIZONA	30	30	30	Yes	8
ARKANSAS	21	—	24	No	12 wks
CALIFORNIA	45	45 (Biological, Physical)		No	***
COLORADO	*	*	*	Yes	400 hrs
CONNECTICUT	18	—	18	No	6
DELAWARE	30	—	39-45	Yes	6
DIST. OF COLUMBIA	27	30	30	Yes	1 sem.
FLORIDA	21	—	30	Yes(S)	6
GEORGIA	60 qtr	45 qtr	40 qtr	Yes(M)	15 qtr hrs
HAWAII	*		*	*	*
IDAHO	20	45	20	No	6
ILLINOIS	24	32	24	Yes	5
INDIANA	36	36	36	Yes	9 wks
IOWA	24	24	24	Yes	Yes
KANSAS	*	*	*	*	*
KENTUCKY	30	48	30	No	9-12
LOUISIANA	20	—	20	No	9
MAINE	18	18	—	Yes	6
MARYLAND	24	36	24	Yes	6
MASSACHUSETTS	36	36	36	Yes	300 hrs
MICHIGAN	30	30	30	No	6
MINNESOTA	**	**	**	**	**
MISSISSIPPI	24	—	32	Yes(S)	6
MISSOURI	30	30	20	Yes	8
MONTANA	30	60	30	Yes	10 wks
NEBRASKA	30	45	24	Yes	320 hrs
NEVADA	16	36	16	No	8
NEW HAMPSHIRE	*	*	*	*	*
NEW JERSEY	30	30	30	No	*
NEW MEXICO	24	24	24	Yes	6
NEW YORK	24	—	36	No	*
NORTH CAROLINA	**	**	**	**	**
NORTH DAKOTA	16	21	12	No	6
OHIO	30	30	30	No	*
OKLAHOMA	40	—	40	No	12 wks
OREGON	21	45	45	Yes(M)	15 qtr hrs
PENNSYLVANIA	*	*	*	*	*
RHODE ISLAND	30	30	30	Yes	6
SOUTH CAROLINA	*	*	*	*	*
SOUTH DAKOTA	18	21	12	No	6
TENNESSEE	36 qtr	48 qtr	24 qtr	Yes	4
TEXAS	24	48	24	No	6
UTAH	**	**	**	**	**
VERMONT	18	18	18	Yes	*
VIRGINIA	27	—	24	No	6
WASHINGTON	24	41	34	No	Yes
WEST VIRGINIA	**	**	**	**	**
WISCONSIN	34	54	34	Yes	5
WYOMING	24	30	12	No	1 course

— No certification offered

Course credits = Semester credit hours, unless otherwise specified (e.g., qtr= quarter credit hours)

*Certification requirements determined by degree-granting institution or approved/competency-based program.

**Major or minor: North Dakota, Utah; 20-40% of program: Minnesota, North Carolina; Courses matched with job requirements: West Virginia.

***1 semester full-time or 2 semesters half-time: California; supervised teaching experience and 300 hours clinical/field-based experience: Ohio.

Source: State Departments of Education, June 1987.

Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990.

Appendix Table B-12
CERTIFICATION STATUS OF MATHEMATICS TEACHERS (Grades 9–12) BY PRIMARY AND SECONDARY ASSIGNMENT

STATE	MATHEMATICS PRIMARY			MATHEMATICS SECONDARY	
	Total	Certified Mathematics	Out-of-Field	Certified Mathematics	Out-of-Field
ALABAMA	1,597	77%	2%	18%	4%
ALASKA	—	—	—	—	—
ARIZONA	—	—	—	—	—
ARKANSAS	(P) 650	95%	5%	—	—
CALIFORNIA	9,684	61%	7%	20%	12%
COLORADO	1,297	67%	23%	2%	8%
CONNECTICUT	1,453	95%	0%	5%	0%
DELAWARE	(P) 240	95%	5%	—	—
DIST OF COLUMBIA	—	—	—	—	—
FLORIDA	—	—	—	—	—
GEORGIA	—	—	—	—	—
HAWAII	—	—	—	—	—
IDAHO	649	68%	2%	29%	1%
ILLINOIS	3,745	75%	21%	3%	.5%
INDIANA	—	—	—	—	—
IOWA	—	—	—	—	—
KANSAS	—	—	—	—	—
KENTUCKY	1,659	80%	2%	9%	9%
LOUISIANA	—	—	—	—	—
MAINE	—	—	—	—	—
MARYLAND	(P) 2,298	99%	1%	—	—
MASSACHUSETTS	—	—	—	—	—
MICHIGAN	—	—	—	—	—
MINNESOTA	1,811	71%	1%	26%	2%
MISSISSIPPI	719	85%	5%	8%	2%
MISSOURI	1,999	85%	1%	14%	1%
MONTANA	535	62%	4%	23%	11%
NEBRASKA	—	—	—	—	—
NEVADA	673	66%	10%	17%	7%
NEW HAMPSHIRE	—	—	—	—	—
NEW JERSEY	(P) 4,375	100%	0%	—	—
NEW MEXICO	643	82%	1%	16%	1%
NEW YORK	7,853	70%	3%	22%	5%
NORTH CAROLINA	2,966	87%	3%	8%	2%
NORTH DAKOTA	471	66%	0%	34%	0%
OHIO	4,254	89%	1%	9%	.5%
OKLAHOMA	1,674	86%	3%	8%	13%
OREGON	1,222	85%	1%	.5%	14%
PENNSYLVANIA	5,704	89%	7%	2%	1%
RHODE ISLAND	(P) 418	100%	0%	—	—
SOUTH CAROLINA	1,853	86%	5%	6%	4%
SOUTH DAKOTA	707	35%	30%	13%	22%
TENNESSEE	1,872	73%	1%	13%	3%
TEXAS	—	—	—	—	—
UTAH	1,114	66%	3%	28%	3%
VERMONT	—	—	—	—	—
VIRGINIA	3,114	81%	1%	16%	2%
WASHINGTON	—	—	—	—	—
WEST VIRGINIA		—	—	—	—
WISCONSIN	—	—	—	—	—
WYOMING	—	—	—	—	—
MEDIAN		81%	2%	13%	3%
TOTAL (30 states)	67,249	79%	5%	12%	4%

Note: Several state percentages include teachers with general secondary certification: Alabama—Primary, 2 teachers, Secondary, 8 teachers, California—Primary, 1,151 teachers, Secondary, 719 teachers; Idaho—Primary, 1 teacher, Secondary, 29 teachers; Illinois—Computer certification codes do not distinguish general secondary from math certified.

Out-of-Field=Regular/standard/probationary certification in a field/subject other than the one assigned or temporary, provisional or emergency certification; (P) Only teachers with primary assignment reported.

Source: State Departments of Education, Data on Public Schools, Fall 1989; N. Carolina, Fall 1988

Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table B-13
CERTIFICATION STATUS OF BIOLOGY TEACHERS (Grades 9–12) BY PRIMARY AND SECONDARY ASSIGNMENT

		BIOLOGY PRIMARY			BIOLOGY SECONDARY		
STATE	Total	Certified Biology	Certified Broad Field	Out-of-Field	Certified Biology	Certified Broad Field	Out-of-Field
ALABAMA	809	49%	11%	.2%	27%	11%	1%
ALASKA	—	—	—	—	—	—	—
ARIZONA	—	—	—	—	—	—	—
ARKANSAS	518	37%	4%	14%	17%	8%	20%
CALIFORNIA	3,733	0%	53%	6%	0%	31%	9%
COLORADO	—	—	—	—	—	—	—
CONNECTICUT	620	78%	0%	0%	22%	0%	0%
DELAWARE	(P) 55	78%	11%	11%	—	—	—
DIST OF COLUMBIA	—	—	—	—	—	—	—
FLORIDA	—	—	—	—	—	—	—
GEORGIA	—	—	—	—	—	—	—
HAWAII	—	—	—	—	—	—	—
IDAHO	270	42%	6%	1%	37%	14%	0%
ILLINOIS	1,312	0%	75%	22%	0%	2%	.2%
INDIANA	—	—	—	—	—	—	—
IOWA	—	—	—	—	—	—	—
KANSAS	—	—	—	—	—	—	—
KENTUCKY	689	33%	1%	.3%	62%	3%	1%
LOUISIANA	—	—	—	—	—	—	—
MAINE	—	—	—	—	—	—	—
MARYLAND	—	—	—	—	—	—	—
MASSACHUSETTS	—	—	—	—	—	—	—
MICHIGAN	—	—	—	—	—	—	—
MINNESOTA	715	46%	14%	1%	29%	8%	2%
MISSISSIPPI	398	71%	0%	6%	18%	0%	5%
MISSOURI	986	64%	0%	1%	33%	0%	2%
MONTANA	236	31%	6%	1%	33%	25%	3%
NEBRASKA	—	—	—	—	—	—	—
NEVADA	213	13%	44%	2%	7%	34%	0%
NEW HAMPSHIRE	—	—	—	—	—	—	—
NEW JERSEY	(P) 887	0%	100%	0%	—	—	—
NEW MEXICO	—	—	—	—	—	—	—
NEW YORK	5,180	62%	0%	3%	29%	0%	6%
NORTH CAROLINA	1,181	47%	39%	1%	6%	5%	1%
NORTH DAKOTA	262	23%	3%	0%	52%	22%	0%
OHIO	1,695	15%	57%	0%	10%	17%	0%
OKLAHOMA	901	62%	0%	1%	35%	0%	2%
OREGON	338	82%	0%	1%	11%	0%	6%
PENNSYLVANIA	1,755	81%	5%	4%	9%	1%	.3%
RHODE ISLAND	(P) 155	98%	2%	0%	—	—	—
SOUTH CAROLINA	615	39%	31%	1%	10%	15%	4%
SOUTH DAKOTA	230	23%	12%	3%	31%	9%	22%
TENNESSEE	709	67%	0%	.4%	28%	0%	1%
TEXAS	—	—	—	—	—	—	—
UTAH	505	56%	0%	9%	33%	0%	2%
VERMONT	—	—	—	—	—	—	—
VIRGINIA	994	75%	0%	2%	21%	0%	2%
WASHINGTON	—	—	—	—	—	—	—
WEST VIRGINIA	—	—	—	—	—	—	—
WISCONSIN	—	—	—	—	—	—	—
WYOMING	—	—	—	—	—	—	—
MEDIAN		47%	5%	1%	22%	5%	2%
TOTAL (27 states)	25,961	43%	23%	4%	18%	8%	4%

Note: Several state percentages include teachers with general secondary certification: Alabama—Primary, 1 teacher; California—Primary, 370 teachers, Secondary, 260 teachers; Idaho—Secondary, 8 teachers; Illinois—Computer certification codes do not distinguish general, broad, and biology certification.

Out-of-Field=Regular/standard/probationary certification in a field/subject other than the one assigned or temporary, provisional or emergency certification.

(P) Only teachers with primary assignment reported.

Source: State Departments of Education, Data on Public Schools, Fall 1989; N. Carolina, Fall 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table B-14
CERTIFICATION STATUS OF CHEMISTRY TEACHERS (Grades 9–12) BY PRIMARY AND SECONDARY ASSIGNMENT

		CHEMISTRY PRIMARY			CHEMISTRY SECONDARY		
STATE	Total	Certified Chemistry	Certified Broad Field	Out-of-Field	Certified Chemistry	Certified Broad Field	Out-of-Field
ALABAMA	380	20%	14%	1%	28%	31%	6%
ALASKA	—	—	—	—	—	—	—
ARIZONA	—	—	—	—	—	—	—
ARKANSAS	283	15%	6%	5%	18%	32%	24%
CALIFORNIA	1,308	0%	45%	8%	0%	38%	9%
COLORADO	—	—	—	—	—	—	—
CONNECTICUT	373	68%	0%	0%	32%	0%	0%
DELAWARE	(P) 17	82%	12%	6%	—	—	—
DIST OF COLUMBIA	—	—	—	—	—	—	—
FLORIDA	—	—	—	—	—	—	—
GEORGIA	—	—	—	—	—	—	—
HAWAII	—	—	—	—	—	—	—
IDAHO	129	9%	6%	1%	29%	53%	2%
ILLINOIS	654	0%	84%	16%	0%	.5%	0%
INDIANA	—	—	—	—	—	—	—
IOWA	—	—	—	—	—	—	—
KANSAS	—	—	—	—	—	—	—
KENTUCKY	345	39%	4%	.3%	45%	8%	4%
LOUISIANA	—	—	—	—	—	—	—
MAINE	—	—	—	—	—	—	—
MARYLAND	—	—	—	—	—	—	—
MASSACHUSETTS	—	—	—	—	—	—	—
MICHIGAN	—	—	—	—	—	—	—
MINNESOTA	475	23%	15%	2%	33%	19%	8%
MISSISSIPPI	141	53%	0%	11%	20%	0%	16%
MISSOURI	574	39%	0%	1%	55%	0%	5%
MONTANA	154	14%	3%	1%	50%	29%	3%
NEBRASKA	—	—	—	—	—	—	—
NEVADA	69	23%	35%	0%	6%	36%	0%
NEW HAMPSHIRE	—	—	—	—	—	—	—
NEW JERSEY	(P) 337	0%	100%	0%	—	—	—
NEW MEXICO	—	—	—	—	—	—	—
NEW YORK	1,864	64%	0%	2%	28%	0%	6%
NORTH CAROLINA	553	22%	63%	.4%	3%	12%	.4%
NORTH DAKOTA	174	6%	5%	0%	29%	60%	0%
OHIO	985	29%	35%	0%	18%	17%	.3%
OKLAHOMA	481	29%	0%	.4%	66%	0%	4%
OREGON	—	—	—	—	—	—	—
PENNSYLVANIA	1,016	66%	15%	3%	9%	6%	.4%
RHODE ISLAND	(P) 77	90%	10%	0%	—	—	—
SOUTH CAROLINA	324	13%	49%	1%	4%	27%	6%
SOUTH DAKOTA	151	8%	10%	2%	12%	24%	44%
TENNESSEE	357	59%	0%	0%	37%	0%	3%
TEXAS	—	—	—	—	—	—	—
UTAH	105	59%	0%	3%	37%	0%	1%
VERMONT	—	—	—	—	—	—	—
VIRGINIA	543	72%	0%	2%	23%	0%	4%
WASHINGTON	—	—	—	—	—	—	—
WEST VIRGINIA	—	—	—	—	—	—	—
WISCONSIN	—	—	—	—	—	—	—
WYOMING	—	—	—	—	—	—	—
MEDIAN		23%	6%	1%	28%	12%	4%
TOTAL (26 states)	11,869	35%	22%	3%	22%	13%	5%

Note: Several state percentages include teachers with general secondary certification: California—Primary, 130 teachers, Secondary, 72 teachers; Idaho—Primary, 1 teacher, Secondary, 19 teachers; Illinois—Computer certification codes do not distinguish general, broad, and chemistry certification; Rhode Island—Primary, 2 teachers

Out-of-Field=Regular/standard/probationary certification in a field/subject other than the one assigned or temporary, provisional or emergency certification.

(P) Only teachers with primary assignment reported.

Source: State Departments of Education, Data on Public Schools, Fall 1989; N. Carolina, Fall 1988

Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table B-15
CERTIFICATION STATUS OF PHYSICS TEACHERS (Grades 9–12)
BY PRIMARY AND SECONDARY ASSIGNMENT

		PHYSICS PRIMARY			PHYSICS SECONDARY		
STATE	Total	Certified Physics	Certified Broad Field	Out-of-Field	Certified Physics	Certified Broad Field	Out-of-Field
ALABAMA	305	4%	8%	6%	10%	55%	17%
ALASKA	—	—	—	—	—	—	—
ARIZONA	—	—	—	—	—	—	—
ARKANSAS	220	2%	1%	1%	24%	54%	17%
CALIFORNIA	868	0%	23%	4%	0%	61%	11%
COLORADO	—	—	—	—	—	—	—
CONNECTICUT	243	52%	0%	0%	48%	0%	0%
DELAWARE	(P) 41	37%	39%	24%	—	—	—
DIST OF COLUMBIA	—	—	—	—	—	—	—
FLORIDA	—	—	—	—	—	—	—
GEORGIA	—	—	—	—	—	—	—
HAWAII	—	—	—	—	—	—	—
IDAHO	104	2%	3%	0%	19%	72%	4%
ILLINOIS	293	0%	79%	19%	0%	2%	.3%
INDIANA	—	—	—	—	—	—	—
IOWA	—	—	—	—	—	—	—
KANSAS	—	—	—	—	—	—	—
KENTUCKY	220	7%	1%	0%	64%	15%	13%
LOUISIANA	—	—	—	—	—	—	—
MAINE	—	—	—	—	—	—	—
MARYLAND	—	—	—	—	—	—	—
MASSACHUSETTS	—	—	—	—	—	—	—
MICHIGAN	—	—	—	—	—	—	—
MINNESOTA	366	14%	9%	1%	40%	27%	9%
MISSISSIPPI	46	22%	0%	4%	26%	0%	48%
MISSOURI	361	15%	0%	1%	70%	0%	14%
MONTANA	132	8%	3%	0%	33%	44%	13%
NEBRASKA	—	—	—	—	—	—	—
NEVADA	41	10%	20%	2%	17%	51%	0%
NEW HAMPSHIRE	—	—	—	—	—	—	—
NEW JERSEY	(P) 82	0%	100%	0%	—	—	—
NEW MEXICO	—	—	—	—	—	—	—
NEW YORK	1,158	49%	0%	3%	32%	0%	16%
NORTH CAROLINA	331	10%	66%	4%	2%	18%	1%
NORTH DAKOTA	125	1%	4%	0%	14%	82%	0%
OHIO	751	13%	14%	.3%	39%	33%	1%
OKLAHOMA	240	9%	0%	1%	76%	0%	14%
OREGON	—	—	—	—	—	—	—
PENNSYLVANIA	670	52%	14%	4%	15%	13%	2%
RHODE ISLAND	(P) 44	84%	16%	0%	—	—	—
SOUTH CAROLINA	210	3%	14%	1%	7%	68%	7%
SOUTH DAKOTA	125	2%	3%	1%	7%	27%	60%
TENNESSEE	238	13%	0%	0%	75%	0%	9%
TEXAS	—	—	—	—	—	—	—
UTAH	69	33%	0%	1%	61%	0%	4%
VERMONT	—	—	—	—	—	—	—
VIRGINIA	323	41%	0%	2%	47%	0%	10%
WASHINGTON	—	—	—	—	—	—	—
WEST VIRGINIA	—	—	—	—	—	—	—
WISCONSIN	—	—	—	—	—	—	—
WYOMING	—	—	—	—	—	—	—
MEDIAN		10%	4%	1%	26%	18%	9%
TOTAL (26 states)	7,606	21%	15%	3%	29%	23%	9%

Note: Several state percentages include teachers with general secondary certification: California—Primary, 40 teachers, Secondary, 90 teachers; Idaho—Primary, 2 teachers, Secondary, 30 teachers; Illinois—Computer certification codes do not distinguish general, broad, and physics certification; Rhode Island—Primary, 1 teacher

Out-of-Field=Regular/standard/probationary certification in a field/subject other than the one assigned or temporary, provisional or emergency certification.

(P) Only teachers with primary assignment reported.

Source: State Departments of Education, Data on Public Schools, Fall 1989; N. Carolina, Fall 1988

Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

Appendix Table B-16
MATHEMATICS AND SCIENCE TEACHERS (Grades 9-12) WITH COLLEGE MAJOR IN MATHEMATICS OR MATHEMATICS EDUCATION/ SCIENCE OR SCIENCE EDUCATION

	All Teachers of Mathematics % w/Major in Math or Math Education	All Teachers of Science % w/Major in Science or Science Education
ALABAMA	69%	63%
ALASKA	32	55
ARIZONA	—	51
ARKANSAS	63	54
CALIFORNIA	37	54
COLORADO	55	75
CONNECTICUT	57	67
DELAWARE	—	—
DIST OF COLUMBIA	—	—
FLORIDA	60	67
GEORGIA	76	62
HAWAII	—	—
IDAHO	60	52
ILLINOIS	67	63
INDIANA	59	65
IOWA	64	68
KANSAS	74	44
KENTUCKY	73	67
LOUISIANA	55	44
MAINE	49	57
MARYLAND	90	—
MASSACHUSETTS	61	62
MICHIGAN	71	68
MINNESOTA	75	82
MISSISSIPPI	77	72
MISSOURI	71	76
MONTANA	62	68
NEBRASKA	67	55
NEVADA	—	—
NEW HAMPSHIRE	—	—
NEW JERSEY	73	82
NEW MEXICO	57	54
NEW YORK	67	69
NORTH CAROLINA	60	64
NORTH DAKOTA	65	74
OHIO	68	71
OKLAHOMA	52	56
OREGON	42	66
PENNSYLVANIA	83	81
RHODE ISLAND	—	—
SOUTH CAROLINA	68	78
SOUTH DAKOTA	65	44
TENNESSEE	57	44
TEXAS	60	57
UTAH	40	37
VERMONT	—	—
VIRGINIA	71	77
WASHINGTON	43	43
WEST VIRGINIA	74	58
WISCONSIN	76	77
WYOMING	55	49
U.S. TOTAL	63%	64%

— Too few cases for a reliable estimate.
Source: Schools and Staffing Survey, National Center for Education Statistics, Spring 1988
Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1990

APPENDIX C
Technical Appendix

Computation of estimated proportion of high school students taking selected mathematics and science courses by graduation (Tables 1 and 2).

The percentages shown in Tables 1 and 2 for each course are statistical estimates of course taking of high school students by the time they graduate, based on the total course enrollment in grades 9-12 as of Fall 1989 divided by the estimated number of students in a grade cohort during four years of high school.

Synthetic cohort statistics have been used previously in education. For example, a synthetic high school dropout statistic has been estimated, based on the sum of the percentages of students who drop out at each grade, for grades 9-12 (Kominsky, 1987). Cross-sectional data on dropouts by grade are used to estimate a true dropout rate over a four year period of high school. A true dropout rate requires tracking the status of the same group of students (cohort) through four years of high school. If only cross-sectional data are available, the synthetic cohort statistic provides an estimate of the high school dropout rate.

The Science and Mathematics Indicators Project desired a synthetic cohort statistic of the proportion of graduates in a state that take a given course, e.g., algebra 1. Since most states do not collect data by grade, the approach used in computing a synthetic dropout statistic for dropouts had to be revised. First, the numerator is the total number of students in grades 9-12 that took a given course, e.g., algebra 1, in Fall 1989. The denominator is an estimate of the number of students in a cohort of students summed over a four year period of high school. For each state, the size of the cohort of students that have some probability of taking a given course, e.g., algebra 1, during four years of high school is estimated by: the state student membership in each grade (for grades 9-12) weighted by the regional percentage of students that took the course at each grade level, and summing the weighted memberships for each grade for grades 9-12. The state student memberships by grade are from the 1989-90 Common Core of Data (NCES) and the regional percentages were obtained from the 1987 National Transcript Study (Westat, 1988).

The computation of the science/mathematics course taking synthetic cohort statistic can be summarized as follows using the example of algebra 1:

$$\text{Estimated proportion of students taking algebra 1 in state A} = \frac{\text{Algebra 1 enrollment (9-12) (reported by State A)}}{\text{Estimated number of students in cohort in grades 9-12 (from CCD and regional weights based on NAEP transcript study)}}$$

$$\text{Estimated students in cohort} = (\text{M9 X Alg 1/9}) + (\text{M10 X Alg 1/10}) + (\text{M11 X Alg 1/11}) + \text{in cohort } (\text{M12 X Alg 1/12})$$

where, M9 is the student membership for grade 9 (from NCES Common Core of Data) Alg 1/9 is the percentage of 1987 graduates in state A's region that took algebra 1 in grade 9 (from Westat, Inc. transcript data files). (Four regions were designated by Westat—Northeast, North Central, South Central, and West.)

The synthetic cohort statistic for rates of course taking is not directly comparable to course taking rates based on student transcripts, such as from the 1987 national transcript study. Beyond differences in data collection methods (universe vs. sample), there are at least two reasons for the synthetic cohort estimate to vary from a true rate based on tracking individual students. First, as with any synthetic cohort statistic, changes in policies or programs over a four year period of time (such as changes in state graduation requirements) that affect student behavior (such as course taking) are not accounted for by the statistic. Second, state course enrollment totals can include students taking a course a second time to earn a credit. The synthetic cohort statistic in this report, which is based on state cross-sectional counts, may be slightly higher than the true rate based on tracking individual students (who are typically counted only once per course credit). Currently, no data are available by state to determine the number of students repeating courses.

Variability is added to the state estimates through the weighted student membership based on regional weights. Since the weights are not state specific, each estimate has variability. For this reason, estimates over 95 percent of students cannot be made with precision and enrollments at this level are shown in Tables 1 and 2 as 95+ percent.

Course enrollment rates are based on enrollment as of Fall 1989. Some states collect data on student course taking for fall and spring semesters. The state comparisons are based on cross-sectional data collected as of October 1. The indicator does not account for variation in course taking as of the spring semester.

Imputation of estimated proportion of high school graduates taking selected mathematics and science courses for non-reporting states.

In 1989-90, 13 states were not able to report course enrollment data to CCSSO. To obtain a national total for the estimated proportion of graduates taking selected mathematics and science courses, the state proportions were imputed. The following formula was used for imputation:

$$\text{Estimated proportion of students taking algebra 1 in non-reporting state B} = \frac{\text{(Reg. avg. \% taking algebra 1 (9-12)} \times \text{state B student membership (9-12))}}{\text{Sum of estimated numbers of students in cohort in grades 9-12 from CCD and regional weights based on NAEP transcript study) (as above)}}$$

where, Reg. avg. % taking algebra 1 is the average (mean) percent of students taking algebra 1 among the reporting states in state B's region.

Imputation of number of teachers per field (in mathematics, biology, chemistry, physics, and earth science) for non-reporting states.

$$\text{Imputed number of teachers of mathematics in state C} = \frac{\text{State student membership (9-12)}}{\text{Regional ratio students/teacher}} \times \text{Regional ratio mathematics teachers to total teachers (9-12)}$$

$$\text{Regional ratio students/teacher} = \frac{\text{State student membership (9-12)}}{\text{State total teachers (9-12)}} \quad \text{Averaged for states in region}$$

$$\text{Regional ratio mathematics teachers to total teachers} = \frac{\text{State mathematics teachers (9-12)}}{\text{State total teachers (9-12)}} \quad \text{Averaged for states in region}$$

APPENDIX D
Directory Of State Course Titles By Reporting Categories For Science/Math Indicators

Science Course Categories

Sample of State Course Titles (from State data forms)

Grades 7-8

General Science
General Science 7,8
Earth/Life/Physical Science 7,8
Integrated Science 7,8
Life Science
Life Science 7,8; Biological Science 7,8
Physical Science
Physical Science 7,8
Other Science, 7-8

Grades 9-12

Biology, 1st Year, General
Biology I; General; College Prep.; Regents; Introductory
Biology, 1st Year, Applied
Basic Biology; Applied; Life Science; Lab Techniques(Biol.); Biomedical Ed.; Animal Science; Horticultural Sci.; Bio Science; Health Science; Nutrition; Man & Disease; Agricul. Science; Fundamentals of Biology
Biology, 2nd Year, Advanced Placement
Advanced Placement Biology
Biology, 2nd Year, Other Advanced
Biology II; Advanced; College; Marine Biology;Psychobiology; Physiology; Anatomy; Zoology; Botany; Microbiology; Genetics; Cell Biology; Embryology; Invertebrate/Vertebrate Biology; Molecular Biology
Chemistry, 1st Year, General
Chemistry I; General; Introductory; Regents
Chemistry, 1st Year, Applied
Applied Chemistry; Consumer; Technical Chemistry; Lab techniques (chem.); Practical Chemistry
Chemistry, 2nd Year, Advanced Placement
Advanced Placement Chemistry
Chemistry, 2nd Year, Other Advanced
Chemistry II; Advanced; College; Organic; Inorganic; Physical; Biochemistry, Analytical
Physics, 1st Year, General
Physics I; General; Regents; Introductory
Physics, 1st Year, Applied
Applied Physics; Applied Physical Science; Electronics; Radiation Physics; Lab Techniques
Physics, 2nd Year, Advanced Placement
Advanced Placement Physics
Physics, 2nd Year, Other Advanced
Physics II; Advanced; College; Nuclear Physics; Atomic Physics
Earth Science, 1st Year, General
Earth Science; Earth-Space Science; Regents Earth Science
Earth Science, 1st Year, Applied
Applied Earth Science; Fundamentals of Earth Science;Soil Science
Earth Science, 2nd Year, Advanced
Advanced Earth Science; Meteorology; Geology; Astronomy; Oceanography
General Science
General Science; Basic; Introductory; Unified; Comprehensive Ideas and Investigations in Science; Life/Physical Science; Integrated Science;Earth/Life/Physical
Physical Science
Physical Science; Interaction Matter and Energy
Other Science, 9-12
Science/Math; Engineering; Bioengineering; Special Interests Science; Ecology; Environmental Science; Electricity; Energy; Research Topics; Science-Technology-Society; Aerospace Science.

Mathematics Course Categories

Sample of State Course Titles (from State data forms)

Grades 7-8

Math, Grade 7
Math 7; Exper. Math 7 - SS MCIS; Remedial Math 7
Math, Grade 7, Accelerated
Accelerated Math 7; Pre-Algebra; Introductory Algebra
Math, Grade 8
Math 8; Exper. Math 8 - SS MCIS; Pre-Algebra; Remedial Math 8
Math Grade 8, Accelerated
Accelerated Math 8; Algebra 1; Beginning Algebra; Elementary Algebra
Math Grade 8, Algebra 1
Algebra 1; Beginning Algebra; Elementary Algebra

Grades 9-12

Review Mathematics

Level 1
General Math 1; Basic Math; Math 9; Remedial Math; Developmental; H.S. Arithmetic; Math Comp Test; Comprehensive Math; Terminal Math

Level 2
General Math 2; Vocational Math; Applied; Consumer; Technical; Business; Shop; Math 10; Career Math; Practical Math; Essential Math; Cultural Math

Level 3
General Math 3; Math 11; Intermediate Math; Applied Math II

Level 4
General Math 4; Math 12; Advanced Math

Informal Mathematics

Level 1
Pre-Algebra; Introductory Algebra; Basic; Applications; Algebra 1A (first year of two-year sequence); Non-College Algebra

Level 2
Basic Geometry; Informal; Practical; Core

Level 3
Basic Algebra 2; Mathematics of Consumer Economics

Formal Mathematics

Level 1
Algebra 1; Elementary; Beginning; Unified Math I; Integrated Math 1; Algebra 1B (second year of two year sequence)

Level 2
Geometry; Plane Geometry; Solid Geometry; Integrated Math 2; Unified Math II

Level 3
Algebra 2; Intermediate; Algebra and Trigonometry; Algebra and Analytic Geometry; Integrated Math 3; Unified Math III

Level 4
Algebra 3; Trigonometry; Advanced Algebra; College Algebra; Pre-Calculus; Analytic/Advanced Geometry; Trigonometry and Analytic/Solid Geometry; Math Topics; Intro. to College Math; Number Theory; Math IV; College Prep Sr. Math; Elem. Functions

Level 5
Calculus and Analytic Geometry; Calculus; Abstract Algebra; Differential Equations; Multivariate Calculus; Linear Algebra; Probability; Statistics; Theory of Equations; Vectors/Matrix Algebra; Math Analysis

Level 5, Advanced Placement
Advanced Placement Calculus

Computer Science Course Categories

Grades 7-8

Computer Science/Computer Programming
Introductory Programming (any language)

Grades 9-12

Computer Science/Programming I
Introductory Programming (any language); Programming I; Computer Language I

Advanced Computer Science/Programming II
Advanced Programming; Programming II; Computer Language II

Computer Science, Advanced Placement
Advanced Placement Computer Science

Source: "Instructions and Reporting Forms for Data on Science and Mathematics Education in (each state)." Council of Chief State School Officers, State Education Assessment Center, Washington, DC, 1989.

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